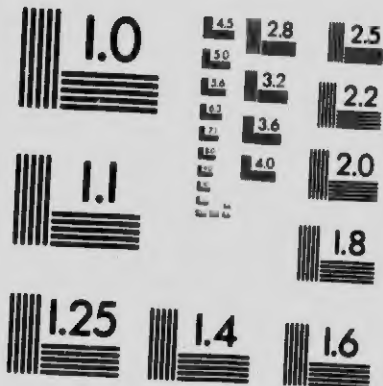


MICROCOPY RESOLUTION TEST CHART

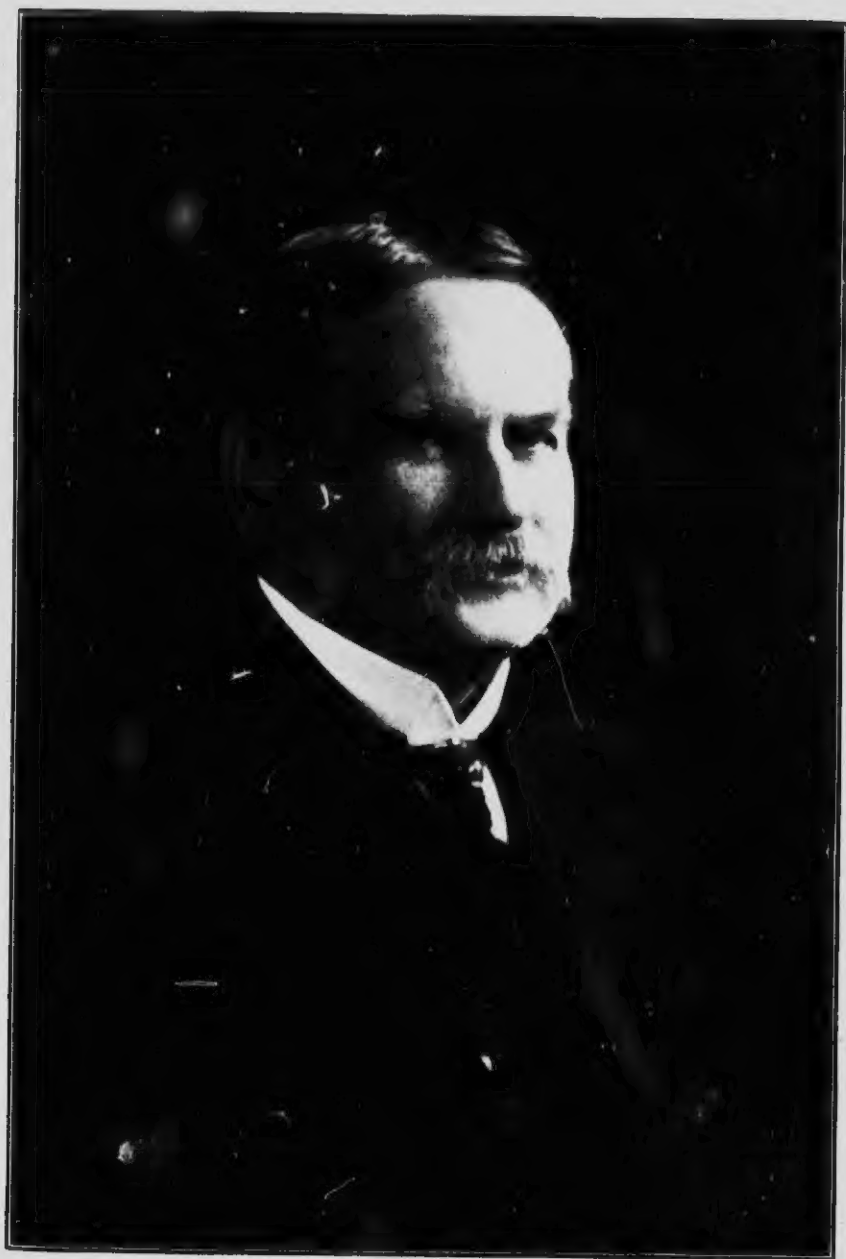
(ANSI and ISO TEST CHART No. 2)



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JOHN LIVINGSTONE, *Author.*

THE LIVINGSTONE WAY

THE ONLY WAY OF RELIEF FROM

SMOKE, CINDERS, SPARKS, SOOT
AND EXPLOSIONS

NOT BY ANY SMOKE-CONSUMING DELUSION OR SNARE

THESE MEN PROTECT THE PUBLIC

Think of the man with the shovel, think of the man at the throttle ; they step onto the engine fresh from the erecting shop in fullest confidence in its design and in the work and material from the shops ; the engineer has his eyes on its gauges, its working parts, and the track, low water can rarely be charged to him ; with their open eyes they are constant watchers, their lives require that they be so, and for their engine they depend upon the master-mechanic and men in the shops. It is in the power of the Presidents of Railways to assure safety to the men in the Cab, and perfect combustion in the furnaces.

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1913

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The contents are not paged, the whole should be read with this page.

Dr. Joseph A. Holmes, director of the U.S. Bureau of Mines has said:

"Probably not over 11 per cent. of the energy in the coal is being effectively utilized. The remainder of the energy is lost through the inefficiency of the steam boiler. It is estimated that the boiler scale in locomotives alone in the United States, means a loss of 15,000,000 tons a year; it has been shown that scale one-sixteenth of an inch thick means a loss of 25 per cent. in boiler efficiency. The losses of carbon that is still pouring out of our chimnies, defacing monuments, buildings, and landscapes—are without valid reason."

Professor Goss, in *Locomotive Sparks*, said:

"The total weight of sparks and cinders passing the heating surface of the boiler of a locomotive * * * may in connection with narrow fireboxes, equal 20 per cent. of the weight of coal fired."

27798 lbs. of five different samples of soft coal fired per hour in the Purdue locomotive, run at different speeds for tests produced 4308.86 pounds of cinders per hour. (The cinders were wasted combustibles.)

COMPARED WITH THOSE SCIENTIFIC CONCLUSIONS.

Mr. Arthur Gilmour sat on top of the cab of C.P.R. locomotive 461, a narrow firebox locomotive, hauling freight trains, on tests which covered 560 miles, without suffering from smoke, only two fistfuls of cinders resulted, there was no soot nor scale in the tubes nor on the heating surfaces, and no sparks left the stack; proof was, so made, that the carbon monoxide was burned in the furnace.

I am of the same opinion as Dr. Holmes—that the losses from smoke, soot, cinders and sparks are without a valid reason.

In pursuing discoveries to abort the smoke nuisance, I discovered that in the production of free hydrogen to assure the combustion of the carbon monoxide, there was at even time with its production a natural way to avert explosions, the lives of the men in the cabs of the locomotives, held, so made, as safe as the lives of the passengers on the train.

Loss of life from explosions is also without a valid reason.

The explosion of the boilers on the U.S.S. Sultana, by which 1500 lives were lost, on the Mississippi in 1865, and of the boilers of the Str. Westfield at her slip in New York in 1871, by which about 200 were killed and injured the destructive Windsor Station disaster in 1909, the Titanic disaster in 1912 with 1517 lives hurried by explosions to the bottom of the ocean after damage from an iceberg, the San Antonio disaster from the explosion of a locomotive boiler by which 32 lives were lost and 50 injured, and the great loss of life from many explosions of locomotive boilers, some published and some suppressed or charged to pseudo causes, all show related causes, and the dangers continued and continuing without considering safety to life, other than in perfunctory regard for the workmanship and quality of the material in the boilers. All concerned should awaken and think.

The Railways of the United States are losing \$100,000,000 a year by not abating the cause of imperfect combustion, which, besides their own loss, injures the people, and by not averting explosions cause anguish to good men and their families as well as loss of life.

After study and consideration of these matters for 26 years, never pursuing the dollars which empirics obtained from unscientific inventions, it cannot be said that I was impelled by selfishness, it is in the interest of the public, to reform in the interest of safety to life and the prolongation of life, by discontinuing the smoke nuisance.

567 University Street, MONTREAL.

JOHN LIVINGSTONE.

PREFACE

A great deal of reliable information has been given by the chemist and scientist to aid the mechanic to invent means to perfect combustion, but not many mechanics understand, and the many mechanics have not had the opportunity with knowledge to demonstrate their appreciation of chemistry, and the chemist or scientist has been ignorant of the way and had not the opportunity with mechanical knowledge in authority to apply his chemical knowledge, and as a consequence generation after generation has been born, have worked their lives out and shortened the lives of one another among the people, producing smoke, soot, cinders, sparks, poisonous gases, and great holes in the ground, prodigally exhausting nature's supplies of fuel, wasting the greater part. utilizing only the smallest part in combustion, taking only the less steaming power from the fuel, increasing the drain upon life by obliging the people to inhale the air, made impure by its diffusion with the smoke from only partly burned coal, the smoke diffusing in the air over large spaces above the earth, the invisible carbon monoxide, at once valuable as a fuel gas, its value wasted in smoke, an injury to human life and a loss to the world by the imperfect combustion of the fuel from which it is produced—as fully described and proved by tests.

Presidents of Railways and Transportation Companies are alike guilty with their engineers for the continual promotion of the smoke nuisance at great loss to the Railways, damage to the people, and loss to the country in which they operate ; and alike responsible for loss of life from explosions, avertible as fully described.

Civic authorities are liable for the consequences from like abuses in stationary boilers ; the civic authorities should be held responsible.

Men and women agitate to save the souls of the heathen, but do not care to be bothered about the bodies of citizens obliged to live in an atmosphere which puts their souls in peril and shortens their allotted span of life, their lungs becoming "absolutely black on the surface and down to their depth."

It is possible to perfect combustion, that is proved, and to avert explosions by which so many are killed and are unjustly blamed.

This therefore is to promote safety to life and arrest the prodigal waste of coal by imperfect combustion.

JOHN LIVINGSTONE.

567 University Street,
Montreal.

INTRODUCTION

Mr. E. P. Ripley, President of the Atchison Topeka & Santa Fe Railway in a circular inaugurating a new Bureau of Safety Department said :

" One of the most serious problems before our company is how to prevent personal injuries, how to avoid the suffering, grief and hardship they occasion, how to eliminate the economic waste caused by the permanent or temporary disablement of a useful individual life. These personal injuries arise mainly from the carelessness of the individual, occasionally from the failure of the material."

My first experience in cause of danger, was with crystallized iron, it was the influence in thrilling and tragic consequences with ruin in my life, and though no railway received any product of that iron from me, iron of that character is no doubt responsible at times for spreading of the rails, a cause for a not very infrequent disaster.

The serious problem applies for all railways, for transportation companies, and for industrial companies, but especially for railways operated by steam, and—

The worst two uneconomic disaster-making evils for railways are smoke and explosions, they cause death, personal injuries and destruction of property. The accompanying pages tell how smoke can be eliminated by the production of hydrogen and the burning of the carbon monoxide, how the explosions can be averted in the production of the hydrogen, the whole at no greater cost than now expended in the staying of the sheets of the fire-boxes of locomotives, getting bettered steam service, with a saving of money to the railways of the United States and Canada of over \$100,000,000 a year. That estimate is based on the present official report of fuel expenses, it is in fact a moderate estimate of the waste of fuel in imperfect combustion as compared with the available energy in the coal when burned to a perfect combustion.

For thirty or more years, the master-mechanics of the rail-

ways have been anxious about the endurance of the staybolts and fearful of breakages and of explosions, if even there was no cause for explosions, other than from cause in the quality in the iron, the carelessness referred to by Mr. Ripley is perhaps more often in the manufacturer of the iron and it is not always accidental; avarice and covetousness being the natural influences, and from those influences—dishonesty, meanness and disastrous consequences follow.

In my very active life, I discovered opportunities, and in my great opportunities of value to the public, there were thieves, as if at my elbow, whose covetousness despoiled the good and deceived the public, making trouble for the people and putting their lives in peril.

All I say in this is relevant; egoism, egotism, covetousness, avarice and graft, having had equal influence with ignorance of the laws of matter in hindering "the how" to perfect combustion, are included in the causes in natural touch with the men whose character is developed in those vices, which refuse consideration of the rights of man from man, and in this case the right to a pure atmosphere and safety to life from explosions.

When the U. S. Patent 853,099 was issued, I intended to promote the conditions desired by Mr. Ripley, for the staybolts used in the furnace, with the iron of a certain maker. I had seen the iron a few years before when it was good and again I saw it, saw it manufactured, saw the iron that was manufactured and saw that it was bad, that it was dangerous to use, that life and property was sure to be endangered, I denounced the maker.

Railway papers and magazines had continued to publish luring advertisements of its character of highest quality, though a bunch of the best men had left the mill, protesting against the iron they were obliged to run through the rolls and were powerless to prevent, and that maker's brother had left for the same reason, the rejections of iron being numerous and irritating.

During the four months following my knowledge of the degradation of the iron, I tried to reform the maker and the iron but success had developed egoism and greed which was apparent in the piling and in friction with men.

I failed to effect a reform in the maker or in the making of the iron and had to postpone my intention to use that iron; there

was then no suitable iron, and I had to postpone the time for promoting the most important development in 100 years.

That maker however had intentions of his own—to manufacture under my patent, as he had done with another years before, and he also desired to have me beside him—to prevent me from communicating with any one else; to secure my presence he asserted that he was about to build a new mill and he wanted me beside him to be his adviser. He did not build a mill.

Quite unsuspecting, I had before that sent him a copy of my patent.

His request to have me at his place as adviser for the pretended new Mill was made in Atlantic City; before leaving Atlantic City for his place, I wrote my New York and Montreal correspondents to put the word PERSONAL on every letter for me, and to address them to the GENERAL DELIVERY, Mr. Maker, who will now be known by the cognomen of Nick, arrived in his home town a day or two before I arrived in the same town, and he was quick to arrange with the local postmaster for letters addressed to me; the fact that they were addressed "Personal" to me, and to the "General Delivery" for me, and that those words on the address, were commands for the Postmaster, to deliver only to me, were of no weight to that Postmaster, and not to be respected by Nick; were they not conspirators treating the Postal laws of the United States with contempt, deriding my rights and the rights of the mailers of the letters so addressed?

I was quick to call at the Post office after my arrival in that town, not the same night, for the post office was closed before I arrived, but the next morning, and was told that Nick had got my letters. Neither Nick nor the Postmaster had a right to change the destination of those letters, and the Inspector sent to investigate had no power to purge the offenders on the false pretences of the accused, who had met in Nick's office to decide what was to be said, when the inspector would come to investigate.

The first two letters in that way addressed, were delivered to me open, by Nick with a mumbled excuse "opened by mistake," but as subsequent letters in the same way addressed, Personal and General Delivery, continued to be opened without my knowledge or consent, it became evident that it was a conspiracy to negative any chance of negotiations for the sale or

working of my said patent ; without any cause for fear he was afraid of some Pittsburg men lest they might get information while there to tempt them into the same business, and when later I said Au revoir, he was so seized with that fear that he was unnecessarily anxious about my movements, whether I was going on to Montreal, and writing to me to Montreal, to know if I had arrived there.

The first two letters were from my said two correspondents, whom I informed of the opening of their letters.

Those correspondents then when writing put their letters in inside envelopes and those envelopes in outside envelopes marked Personal and General Delivery but again they were opened ; but these again in contempt for the U. S. Law and in contempt for the address, were also opened read and delivered, by Mr. Nick, but not with the excuse "opened by mistake," nor with any excuse.

I wondered what would be the result of those inimical acts by Nick and his too willing server, the U. S. local Postmaster, who was dishonest with me, and a conspirator with him ; while however there might be a chance to reform in respect to the iron he was producing, I postponed complaint to the Postmaster General, not however acquiescing in the fraud, nor condoning the wrong, which with every wrong became a crime against the U. S. Postal laws.

Then I ordered my letters to be mailed to me under the word Personal to the Hotel in which I was staying, with the same result, my letters were intercepted and opened. The Hotel did not get them.

Again I changed to have my letters addressed Personal for me to the Hotel Box No, and my letters were intercepted and opened and so delivered by Nick.

Again there was a change, an inside envelope addressed Personal and General Delivery was gummed and glued, it was put into an outside envelope and sealed, the outside envelope was opened ; that was held back for about seven days, then delivered.

I hated to make trouble for Nick, as I had expected to use his iron for business under my patent, the value of which may be estimated in the pages of this book. I name no pages, it is in the public interest to read it all.

Instead of trouble for Nick, I caused my correspondents to write me with the same care under the words "Personal" and "General Delivery", to a town about five miles away from Nick's town.

I there mailed and received my letters.

Nick soon commenced to think there was a change in my ways about Mail, and ostensibly as a convenience to myself, he said—Mr. Livingstone why do you not write your letter in the office instead of in the Hotel, it is more comfortable for you here in the office, and Miss Browne is here to write for you (Miss Brown was the stenographer)? I did not enlighten him why.

His conduct had been so much of a surprise that I then did not trust him.

Though my letters from those and other correspondents came into my hands in that way, there may have been other letters of more importance that were not delivered, and for that presumption there is the following case :

One of the men in Nick's Mill was about to change and wrote to me to my address in New York, asking me to let him know if I heard of an opening to suit him ; I happened to know that there might be an opening in a certain Mill, but I could not trust either Nick or the post-office in their town, I therefore wrote him to a town in which his family lived some miles from Nick's town. His wife received my letter, opened it, then writing a letter of her own, she put both into an envelope and carefully sealing it, she addressed it to her husband, who on opening his wife's envelope, found her letter only.

Some weeks afterwards his wife questioned her husband as to the results from the letter I had sent to him and which she had enclosed. Then he learned that I had replied to him and that my letter had been intercepted, it was taken from his wife's envelope. That letter was never delivered.

There is a law against intercepting letters, and it is enforced by arrest ; the arrests are sometimes reported, as in the case of the Postmaster of Storm King, Dutchess County, N. Y., for detaining, delaying and embezzling a letter.

And a Postmaster did just such acts for Nick—without being arrested.

The breaches of the law per samples aforesaid were not the

only samples of Nick's tricks to keep the patentee and his patent, for he said openly that he feared some one would start another mill in opposition.

One of his conceptions, was commenced by his giving me a list of 10 or more hydraulic engineers, to whom I was to write and tell them that a hydraulic development and a new mill was contemplated, and that it might be in their interest to send a man to look the business over and make some estimates.

What do you purpose paying them ?

Nothing, he said, they will come on the chances of getting the work.

That was not the way, I said, I had treated hydraulic engineers.

About every week thereafter, there was a hydraulic engineer at the office, and about the time of their arrival, Nick would jump into his automobile for a pleasure ride, saying to the hydraulic engineers, men of reputation and ability, as he jumped into his automobile, see Mr. Livingstone, who was to go with them over the scene of the proposed development, a development that developed into an illusion, and time exposed the fact that it was a preintended illusion, to fool me, while he was intercepting my letters, guarding the patentee and the patent 853,099, from communication with any one who might think of taking up the same line of manufacture, with the improvements as in the said patent, the hydraulic engineers, while in good faith, giving their time to what he claimed to want, actually serving him only to keep me employed, not leaving an excuse for me to be employed about the said patent, and with scurvy treatment to the engineers not giving them his attention, their hotel or rail expenses or professional fees, sickening them, though they came at his request from Cleveland, Dayton, Springfield, Chicago, New York, Boston and elsewhere.

Then he wanted me to write to a hydraulic engineer in Columbus, but I refused. the services of the others were obtained on false pretences, my eyes were then opened and I was indisposed to lend myself to be self deceived, to be Nick's tool to obtain by false pretences the presence of the Columbus hydraulic engineer.

On one occasion Nick asked me to go by way of a certain stair and view the fall of water from the riverside. Following the

directions, I entered a dirty old building, climbed through a window, passed up a stair, and was then to pass down another stair; at its right there was a single shaky rail, on the left, many feet below, was the riverside.

I commenced to descend; the second or third step from the top went down under me at the left side; fortunately I was standing erect, the right side of the step not having gone down, the step was on the slope; if my body had been inclined in the slightest to the left, I would have fallen down the precipitous side of the high jagged rock, and my lacerated body would have fallen into the surging waters of the whirlpool, where my head would have been dashed against the rock bank into which the waters had worn a large hole. Only the fact that I was standing erect, not inclining to the left, and not nervous, saved me.

I returned immediately to the office, said nothing, but Nick said:

You had an accident; were you afraid, I said No.

There was no information to be had at the riverside, and it has since been a wonder—why was I sent there, why was I led there. That was in 1907.

The mill has not been built, and the dam has not been built.

But, in the years since, Nick continues and continued to have suggestive advertisements of his iron, which could not be delivered without infringement on the said patent, by him or by any buyers of his iron in expectation of right to the improvements covered under U. S. Patent 853,099. Some time after I said au revoir, he procured the Chief Engineer of the Paris and Orleans Railway of France, to specify his iron for the staybolts and crown stays in 30 locomotives to be made in the United States; the stays for the crown stays were an infringement, the Locomotive Co., which received the order specified for the iron and received the iron.

The character of the iron delivered for the crown stays besides being an infringement on that patent, was a menace to life and property, and is a part of the subject of danger to life and property from explosions.

I warned the parties to the infringement, and they answered by employing a blunderbuss lawyer, to answer me with threats and defiance.

Prior to that, on the day that I said Au revoir, I personally requested the Postmaster in Nick's town, and gave him written notice to re-address all letters that might thereafter come for me to Montreal, as I was then leaving town, and he promised that he would do so; two letters were received; the law in respect to intercepting letters was important, the fact that two letters were received after I left town, was important, and the fact that they were addressed to me was important.

Nick's anxiety about the said patent, to him was the all important, and that local Postmaster turned those letters over to him to read after which, being unimportant letters, they were mailed to Montreal.

After that incident, I gave information to the Postmaster General, and the case was listed under case No. 157244-C.

An Inspector was appointed to report and he reported per letter to me :

"It was the understanding of the Postmaster at..... that you desired your mail placed in a box rented by.....

I was not in Nick's town when he and the local postmaster commenced intercepting letters addressed to me under "Personal" "General Delivery," moreover the addressers of the letters under those words, were masters of the privacy of their letters and the local postmaster had no authority to violate the law by delivering letters so addressed to other than myself. Every new address was an objection to the violation of the law.

There never was any such understanding, I never desired and never expressed a desire to have my mail placed in any box, the letters were ordered to "Personal" and to the "General Delivery".

I was not his employee, he had his regular employees, he was however out of favor with the railways on account of bad iron, and he arranged with me to speak the merits of his iron, which had been disgraced, and was good at the time he telegraphed for me, and again he degraded his make of iron, and made enemies of the railway engineers, and when his product was being returned, as unsuitable and unsafe for staybolts, his desire materialized in the purpose to infringe on my patent 853,099, and to keep others from doing business under that patent, by which it is possible for the railways of the world to save fuel and life as aforesaid.

The first infringement to come under my notice was that in

the 30 locomotives aforesaid built for the Paris & Orleans Railway of France.

I had a blank form of letter with some of it printed in black about the gains to be made in fuel and safety by staying as provided in 853,099 but by way of notice had the following printed thereon in red, from which in this quotation I omit

"The..... staybolt is a scientific problem, a public utility I championed it when it was good, because I liked the problem, and I like to do good. I had hoped to have brought it into general use at no extra cost to its manufacturer..... by combining its use as stays with the uses in the invention described in my patent. But his craze for cheapeners in his piles, regardless of their welding temperatures, and exactions of tonnage from his men, regardless of required welding heats, and his skinning of the mens' wages for faults that were of his own making, made the iron, in use a danger to life and locomotive."

"To recover the character which I had won for his iron (and he had lost) he clutched at the said patent, had cuts made of the drawings and substituted them for his own in railway papers, made stays with intent to infringe, stays which split when installing them, and when condemned; he made others for them and procured a respected locomotive Company to install them in 30 locomotives for the Paris & Orleans Railway, France."

His immunity from consequences for intercepting my letters, was followed later by a visit from an Inspector of the Montreal Post Office, directed (1) by the Postmaster General of the U. S. A., to (2) the Postmaster General of Canada, so the Inspector said, to ask me to not issue that form of letter with the matter in red, that request was an INTERNATIONAL IMPERTINENCE, chargeable to the Postmaster General of Canada as well as the same for the United States, I had however not issued more than about 50 or 60 copies and the Inspector had such a winning way that I promised.

No papers were served, only your promise, said the Inspector is wanted, that you will not issue any more of those letters.

And since, I have seen advertisements in Railway papers and magazines, advertisements which solicited business on representations of worth and quality which could not be given,

and contemplated infringement on my patent, if deluded railway men succumbed to solicitation.

Integrity is essential in the manufacturer to safety in the material, when one quality is advertised and an inferior quality is delivered, there is a breach of contract, loss to the railway and danger to the employees.

JOHN LIVINGSTONE,

567 UNIVERSITY STREET,

MONTREAL.

HOW COMBUSTION IS CHEATED AND SMOKE IS CREATED.

ALSO

HOW SAFETY IS CHEATED AND EXPLOSIONS ARE CREATED.

These are grievances which I have studied ; the first for over 25 years, the second for nearly ten years, with also experience from my memory of an explosion 33 years ago—when its cause was discussed by experienced experts, and experiences by observation and study in the past seven years,

SMOKE

Watt, the Inventor of the steam engine, invented a smoke consumer in 1785 ; the laws of matter and of gases were then not well known, and his smoke consumer, like all smoke consumers since, was no doubt a failure, for history makes no mention of successes in that invention. It is however possible to perfect combustion of the combustibles and in that way only create carbon dioxide and white vapor, the products from perfect combustion.

What Watt failed to accomplish by reason of lack of knowledge 127 years ago, mechanical engineers and graduates of engineering colleges have failed since to accomplish, the latter are in all countries responsible, they acquired knowledge and should have developed inventive ability by which to have produced carbon dioxide and white vapor instead of the products of imperfect combustion known under the common name of smoke.

✱✱

Because of their inefficiency lives have been shortened, lost, injured and property in untold millions of value have been damaged and destroyed.

Information about the laws of matter and of gases, available to such men for years, is now available and readable by every one, including the Presidents and the Stokers or Firemen. They will find the study of the subject interesting. Other officials between the upper and the lower crust of the powers that be, will not need to study the how to create smoke.

For 30 months out of four years, I was very much in touch with the men on the locomotives, from Canada through the United States to Mexico and Cuba, and I can say as a matter of evidence founded on observation made valuable by my practical experience, that it is unjust to blame the Engine men and Firemen on locomotives, as has been done, for the smoke that is made to issue from the smoke stack. They have no opportunity for study. They have been anxious to learn. Instead of opportunity to learn, they have been blamed and have taken the blame without knowing that they were in fault,

To so write may cause resentment; better that to me than the continuing consequent abuses to the public, of which the great coal strikes are samples, for when hundreds of millions are wasted, the wasters skin the workers and the public; the world now suffers, the people pay.

Working men endure much "to keep their job", but they are not responsible for the great waste and losses which have there origin in furnaces and fireboxes; losses which come with disasters to the Railways—and with tragic consequences to the people; losses which should make the men responsible, sleepless, if they feel their responsibilities, and condemn them as unfitted for the great positions of trust and responsibility for which their academic and mechanical abilities otherwise fit them.

I am not writing a line in resentment, all I write is in experience that every person interested, whether a friend or an enemy, may study to determine why he has never succeeded in abating the smoke nuisance, and come to a logical conclusion on how smoke can be abated.

When right overcomes vanity, which is one of the inhering spirits in hinderers of perfect combustion, there will be men who may not be able to tell why the fuel is burned without making smoke, but there will be competent men justly seized of the vanity that is of knowledge able to direct, not as now, charged with unamiable vanity, which refuses good to the people, by the Sir Oracle disparagement of a way of relief, prolonging the days of wasting, continuing the times of cause for disasters, and the losing of life and prolongation of miseries to the sick in impure atmospheres by reason of smoke and noxious gases.

I have before me a Press report of a case in a humble home which tells the effect of one of the noxious gases—carbon monoxide.

A stove pipe fell and two women were asphyxiated by carbon monoxide. The carbon monoxide was a combustible gas that should have been burned. Its origin was due to lack of oxygen. Its escape from the fire before it was burned, was the loss of the gas, and in its escape to the room by the fall of the pipe, two women were asphyxiated.

A large percentage of all the coal put into the firebox of a locomotive is converted into a loss to the Railways and injury to the people by its imperfect combustion, and the production Carbon monoxide.

Every man is responsible for his acts of injury to his fellow-men; when he is a man learned in Engineering, in the laws of matter and gases, he is responsible for the wastes from imperfect combustion, for the smoke that is the warning that large money losses are being inflicted on the Railways, and he is largely, responsible for loss of life and property.

One quotation from a Press telegram, follows as an illustration :

"ENGINE CAUSED FIRE THAT COST SEVEN LIVES AT WINNIPEG :

"Winnipeg, March 14.—It has now been established that the recent fire which cost seven lives here was caused by sparks from a passing locomotive.

Other quotations can be given to show that form of loss from imperfect combustion, one other in condensed quotations as follows :

" Three men were killed and ten were injured when a fast Express Train crashed into a Trolley Car in Winton ; John Driscoll the gate tender had let the gates down to allow a freight train to pass, the locomotive was giving out such heavy clouds of smoke that he was prevented from seeing a Passenger train bearing down at high speed. All the Passengers on the Trolley were killed or injured."

But, if even every consideration other than the fuel loss from imperfect combustion be set aside, it is an inexcusable offence against the public for a man endowed with ability, a collegiate education, influence and authority, to do as he may see fit, regardless of the health of the people, to condemn betterment in combustion, notwithstanding that it in fact means the loss of millions of dollars.

My opinions about the percentage (50%) of loss by the universally imperfect combustion of coal has been in print for over six years ; there has been, no logical denial of that fact, nor any serious effort made by those in positions of authority to give effect to the workings of their brains—if, in their advanced knowledge, they had any desire to make up for the Railways, that great loss ; some bantam may say the waste is not that much.

C. William Siemens, D. C. L., F. R. S., was a great man, speaking on the Coal question in 1872, before the British Association, he said :

"In taking the 105,000,000 tons of coal consumed in this country last year for our basis, I estimate that, if we could make up our minds to consume our coal in a careful and judicious manner, according to our present lights, we should be able to reduce that consumption by 50,000,000 tons."

The same imperfect methods of burning coal in Great Britain obtain here, and on the authority of Mr. Siemens, 40 years ago, never since improved, it is seen that 50 per cent of the coal is wasted.

B. H. Thwaite, C. E., F. C. S., a specialist on the question,

said in 1889: If we take the average annual consumption of the United Kingdom at and assume an actual calorific efficiency of 50 per cent. to have been obtained, and this figure (50%) is much above the mark, the net loss on an average annual capacity of 75,000,000 tons will be 1,400,000,000 in 40 years, and though great, that estimate of loss is only for the United Kingdom, and there chargeable.

Mr. Siemens in the same lecture, in discussing the necessity of using our stores of fuel more economically, said he had been met with the observation that we need not be anxious about leaving fuel for our descendants, that the human mind would invent some other power, when coals would be exhausted, and that would probably be electricity.

I could not, he said, refrain from calling attention to the fact, that electricity is only another form of energy that could no more be created by man than heat, and that it involved the same recourse to our accumulated stores of fuel.

Another quotation from the same speech by Mr. Siemens is something for thinkers to think about, and is cause for users to pause in their waste of coal, lest they wrong posterity, and cause hardship to the present generation greater than in the great coal strike in 1912.

"In looking into the report of the select committee appointed to inquire into the cause of the present dearness of coal, Mr. Siemens said—we find that in 1872 no less than 123,000,000 tons of coal was got up from the mines of England and Wales, notwithstanding famine prices and the Colliers' strike."

"In 1862 the total amount of coal produced amounted to only 83,500,000 tons, showing a yearly average increase in production of 4,000,000 tons.

"If this progressive increase continues our product will be, 30 years hence, the startling figure of 250,000,000 tons."

The "startling figure" of 265,726,000 tons was reached in 1908. "In estimating last year's (1872) increase in price at 8s per ton all round, and after deducting 13,000,000 tons exported, we find that the British consumer had to pay 44,000,000 pounds sterling more than the market value of former years for his

supply of coal, a sufficient sum, one would think, to make him look earnestly into the question of waste fuel, which, as I have been endeavoring to show, is very great indeed.

And the waste in Canada and the United States is relatively as great as the waste which caused the acute conditions of 1872 in Great Britain, and the cruel hardship in the great strikes of 1912 in Great Britain and the United States, the latter and perhaps the former, excuses to advance prices, the prices in the United States already advanced \$1 per ton, while yet the strike is only begun, and not based on the natural law of supply and demand, no scarcity being felt, full cars of coal being stalled in different parts of the coal producing States, carried with the might of capital at the price to consumers of \$1 per ton and the saved wages of the miners to the mine owners, until the supply be taken by the consumers.

FIVE CASES HEREAFTER QUOTED AS A TEXT FOR THE PUBLIC ;

The Civic department of Chicago, have ordained—

1. "That after the first of January 1913, every Railroad Company shall operate and propel any and all cars or trains of cars along, across, over and under any and all streets within the city of Chicago by other power than that of steam or in a manner that will not produce smoke or any noxious gases that injuriously affect the public health, comfort or convenience."

"Tests and calculations under the direction of the Chief smoke inspector, showed 43 per cent of the smoke of Chicago to be from the 26 Railways which also discharged 560 tons of cinders every day in the year."

An able special report resulted, it was read and discussed in the Western Railway Club. After the experience of over 100 years of failure to perfect combustion, the only alternative that could be thought of was electrification of the locomotives of the 26 Railways and 2200 miles of track within the city, at a cost of multi-millions of dollars.

The smoke and noxious gases to be continued as a nuisance outside of the city. The 560 tons of cinders, largely combustible wasted in the city every day in the year.

The 43 per cent of the smoke of the city from the locomotives to be wasted by the locomotives on the outside of the city of Chicago.

No betterment in combustion contemplated, no economy to be attained.

Will the city be free from smoke ?

An immense plant will be required and dense smoke in greater volumes than ever known, will be produced.

2. THE FOLLOWING IS A SAMPLE CASE OF LESS MAGNITUDE
THAN CHICAGO WILL WANT

The New York Edison Co., was prosecuted for promoting a smoke nuisance, it was a combination of 400 small electric plants in Manhattan.

"As finally constructed on two city blocks the plant furnishes practically 90 per cent of the electric power used in Manhattan and the Bronx. It supplies power to 8,237,218 lamps for 100,000 separate consumers."

"In its boiler room the 152 separate boilers produce 275,000 horse power of energy, all within 38,000 cubic feet of space."

"In 1909 that plant burned up 500,718 tons of coal."

The space, power, and fuel required to serve the locomotives of the 26 Railways would be so much greater than the said figures for the Edison Co., that the extent of the smoke nuisance would be intolerable on a considerable part of Chicago, and there would be no economy.

"The Health department of New York in its prosecution of that Co., had the cooperation of Bellevue Hospital, residents in the neighborhood of the Power plant, and several societies for the protection of the city from smoke nuisances."

"That electric plant is the largest industrial plant in the World, concentrated into so small a space."

As in the case of the New York Edison Co., the Chicago health department, its hospitals, and its citizens, with societies for the prevention of the smoke nuisance, would be a menace and perpetual irritation to the men handling the power plant and the locomotives.

In the trial of the New York Edison Co., white sheets of paper smutted with soot and cinders from the chimnies of the power plant were the principal items of the Health Department's evidence on which the company was convicted and fined for maintaining a smoke nuisance. The white sheets of paper had been exposed for 15 minutes in an apartment near the plant. They were speckled black and on this showing it was concluded that living near the power plant meant damages to furniture, the ruin of hangings and drapery, besides personal discomfort.

"Large wall charts showing these experiments with the result in each case, were on file with the Health department, together with a plea from the defendant company that it had done all that it was able, and therefore, ought not to be held responsible for a condition that it was powerless to change."

That plea and the following further evidence in the case, was an absolute denial of usefulness in the methods for preventing smoke :—

"Commissioner Lederle (Chemist for the Board of Health) said that during the time the Health department had been prodding the Electric Co., the Company had spent several hundred thousands of dollars experimenting with smoke consumers, and he knew of no device, save perhaps one, that had not been tried."

"Vice President Lieb, the General Manager, said the Company started with soft coal furnaces. It discarded them for Hard coal furnaces ; and then it developed another nuisance. The smoke disappeared under an automatic stoking system, but a cinder nuisance immediately succeeded it."

"Powdered fuel, shot by air pressure into the furnace was suggested and at an expense of \$10,000 an experimental plant was built to try out the idea. "It failed."

"A new kind of composite stoker was substituted for the Roney stoker, which had been in use up to that time, and as the demand for hard coal was greater than the mines could produce, it was found that the plant had to be got ready for soft coal as a strike might tie up the hard coal regions. This meant the spending of a great deal more money in order to obviate

the disasters that would follow the shutting off of the city's lights."

"When the Health department's men tried to photograph the smoke stacks, scouts were put on the Company's roof to order the feeding of the coal stopped, when photographers appeared."

And all those conditions would worry the management of a plant for the production of the power for the electrification of the locomotives for 26 Railways operating in the city of Chicago over 2200 miles of track.

3. THE FOLLOWING IS A SOOT CASE :

The Lancet, the Leading Medical Journal, this week (Jany 6. 1912) says : That 76,050 tons of soot are deposited annually in London, or an average of $4\frac{1}{2}$ tons an acre. This comes chiefly from ill consumed coal.

4. THE FOLLOWING IS A CINDER AND SPARK CASE :"

In a published compilation of 15 tests, three tests to each sample of five different samples of coal, fired in a locomotive by a well known Professor in Railway engineering, the aggregate loss from cinders in the front end and sparks from the smoke stack, was $15\frac{1}{2}$ per cent. and—Prof. Goss in his book on "Locomotive Sparks", says further :

The total weight of cinders and sparks passing the heating surface of the boiler of a locomotive increases as the rate of combustion is increased, and under conditions approaching maximum production may, in connection with narrow fireboxes, equal 20 per cent of the weight of coal fired.

5. THE WASTE COMBUSTIBLES LOST IN THE ASH PAN :

From Ry and Loco., Engineering ; confirmed by a Milton Hersey analysis of the ashes in a Paper mill boiler :

"In a published test on 95 samples of ashes from 18 points on the Erie Railway, an average of 33 per cent of carbon was found in the ashes.

"It is safe to presume that the ash dropped from all the locomotives in the country contains as much carbon as that analyzed from the Erie ash pans. These apparently small losses aggregate into fortunes when the whole country is taken into account."

As aforesaid, it is possible to create ;

CARBON DIOXIDE AND WHITE VAPOR, the products of perfect combustion. The Carbon dioxide (Carbonic acid) is the resulting gas from a perfect union of the carbon in the burning fuel with the oxygen from the air. The total heat from the union (combustion) is 14,500 units of heat per lb of carbon, having an equivalent evaporation at 212 Fah. of 15 lbs.

CARBON AND HYDROGEN, are the chief combustibles in the coal:

Carbon produces two gases, carbon dioxide and carbon monoxide, both invisible, the carbon dioxide, incombustible, and the carbon monoxide, a combustible gas. The latter is a resultant of insufficient oxygen, and its production in the furnace is a loss of two-thirds of the heat creatable in producing carbon dioxide ;

11.97 parts by weight of carbon will unite in a perfect union with 31.92 parts by weight of oxygen forming—

43.89 parts by weight of carbon dioxide ; the heat emitted in producing that carbon dioxide, so produced in the perfect union, will raise 96,960 parts by weight of water one degree above its temperature of greatest density.

The carbon dioxide so produced in a perfect union with oxygen yields to the furnace the heat of the union and the gas (carbon dioxide), leaves the furnace in its own heat, in passing the heating surfaces of the boiler, if the heating surfaces are coated with soot, it dissolves the soot coatings and leaves the heating surfaces clean, the conduction of the heat through the heating surfaces is then unimpaired.

"According to Bulletin No 11 of the University of Illinois, after 21 months test with a Mogul locomotive, it was found that scale $\frac{1}{32}$ to $\frac{3}{64}$ of an inch thick, caused a loss of 9.55 per cent in the fuel ; and in varying thicknesses up to $\frac{1}{8}$, losses up to 10% to 12%, per cent in fuel."

If the temperature of the furnace is not over the temperature at which carbon ignites, the carbon dioxide will not leave the furnace, being incombustible, it will lower the temperature and hinder the combustion of the fuel on the grate, the particles of carbon so hindered from burning, will fall through the interstices, as shown in the said tests on the Erie Railroad, which discovered in the ashes 33 per cent of carbon so wasted.

Any device in the furnace or firebox tending to hinder the escape of the carbon dioxide from the furnace is a hindrance to perfect combustion, is a cause of soot, and an increase in the cost of the operating expenses.

The carbon burns to carbon dioxide by a perfect union with oxygen, and the carbon burns to carbon monoxide only, by reason of lack of oxygen, the former as aforesaid evolves 14,544 units of heat, and the latter 4,451 units of heat Fah. The former gives out no smoke, the latter causes soot, cinders, sparks, and is a noxious gas with all the accompanying nuisances collectively called smoke. With the smoke, fires, injury to life and health, losses by burning the forests and lumber, for which the lumbermen and others sue the Railways; also irritations to the victims of bronchial and other diseases and tuberculosis.

In the production of carbon monoxide is the beginning of the smoke nuisance; at even time with its formation, the temperature is made less by its loss as a fuel and by the loss of temperature in other fuel, and by a loss of temperature from contact with the carbon dioxide, which is a non-conductor, that should, by getting away (as formed) in the draft, clear the tubes of soot, as when it does not leave the furnace in its heat of evolution, it hinders the combustion on the grate, and causes the imperfect combustion of the combustibles, the formation of carbon monoxide with again the losses of temperature aforesaid.

Many devices have been invented to restrain the gases from leaving the furnace until burned, of such—the brick arch has survived under the plausible theory of giving the gases time to mix before they get away unconsumed, but the combustible gases do not wait to be mixed, they won't wait, all under the arch is most largely only consumed in part (see the smoke stack)

notwithstanding eminent engineers have acquiesced in the fallacious idea, forgetting the importance of having the combustible carbon dioxide removed as formed, and the combustible carbon monoxide (42.86 per cent carbon) burned as formed ; at no time has there been an appreciation of those two essentials to perfect combustion ; the former gas being 1.5277 compared with air at 1. is in its weight encouraged by lower temperature and a brick arch, to remain, and the other gas, carbon monoxide, being .971, lighter than air or oxygen (its constituents not in proportions for perfect combustion) and not having a sufficient temperature, escapes in the draft by way of the heating surfaces of the boiler, depositing soot in the tubes, cinders in the front end, sparks and cinders from the stack.

HYDROGEN :

H. J. PHILLIPS, F. I. C., F. C. S.

Analytical & Consulting Chemist to the
Great Eastern Railway, Author of Engineering Chemistry ;

Has given the heat generated by the combustion of carbon to carbon dioxide as 8080 calories, and to carbon monoxide at 2473 calories. The difference is a great loss.

As carbon monoxide is always in process of formation, inflicting loss on the railways and on the people, it is a wonder that the Presidents of the great Railways do not call a halt.

At the reduction of temperature that follows the formation of that gas, all devices heretofore tried or in use have failed to effect a perfect union to complete the combustion of the carbon monoxide, to carbon dioxide, it is a cause of smoke and an extravagant waste of fuel.

The constituents of carbon monoxide being carbon and oxygen, out of proportions for a perfect union, as aforesaid, they can only be consumed by union with hydrogen, which has firstly an affinity for oxygen, with which it raises the temperature and produces the white vapor, then it enters into union with the carbon, the union with the carbon made possible with oxygen. The heat value of the hydrogen is—

1 lb of hydrogen in union with 8 lbs of oxygen produces.....	62,032 units.
Less the latent heat of the water vapor.....	8,695 units.
Available heat.....	53,337 units.
Waste heat of furnace gases.....	11,520 units.
The effective heat from one pound of hydrogen.	41,817 units.

Mr. Phillips says also: From accurate determinations by Favre and Silberman, it has been found that the amount of heat generated by the combustion of hydrogen is 4.265 times as great as the heat given out by the combustion of the same weight of carbon to carbon dioxide.

The hydrogen being the only furnace gas having the velocity (6050 feet a second) to overtake and combine with carbon monoxide as formed, its diffusive velocity being 3.83 to air at 1. and carbon monoxide at 1.1149, the hydrogen prevents the escape, by consuming the soot, cinders, sparks, and carbon monoxide, the whole, as combustibles, equal to 50 per cent of the value of the fuel, with other wastes and losses of temperature considered.

"The higher the proportion of hydrogen in the fuel, the more gas in the form of combustible hydro-carbons is given off"—and the continued production of hydrogen in the furnace, which is possible in two ways, is the way to immunity from the smoke nuisance, the way to relief from the wasting of the fuel and the way to relief from the allied evils of smoke.

In that way only the smoke nuisance can be eliminated, in every other way for 127 years, the inventions have been failures.

SOME TESTS OF HYDROGEN FOR PERFECT COMBUSTION

I learned something from the explosion of a Pulp boiler in 1878.

At this moment of writing, I see also in the Press reports of the disaster to the Titanic, words of instruction, for later remarks on the value of hydrogen to perfect combustion and avert explosions:

"Three seconds after the leviathan was engulfed a great

spout of water shot upwards either from the waters meeting over the ship's grave, or from the explosions of boilers."

"There must have been at least thirty explosions in the furnace room as the sea-water poured down the funnels and the fires."

The explosions were caused by the water coming into touch with red hot parts of the boilers or other machinery and so releasing the hydrogen, by the disruption of the water or steam, the power so released was irresistible, and it may have torn the inside of the Titanic open.

In 1888 I had a test on a 12 horse power boiler, in that in some of the tests, I sat on a ladder with my face to the wind and about the top of the stack (locomotive type) another man with me, I had no irritations from smoke, cinders or sparks, and the other man was not smudged.

In or about 1890 I had a test on the S. S. Monarch, which had two boilers, each with three furnaces 13' .4" x 12' each 42" in diameter.

The decision of the owner to have these tests, at my expense was at the time the Ship was loading to leave on her first trip and hardly any time was left to me to get ready and similar conditions existed in the short time between the arrival and departure on the second trip; notwithstanding there was evidence as hereafter follows to show that it was an assured fact that the bituminous coal could be burned without making any smoke, the smoke in small measure produced being chargeable to the imperfect and hasty equipment put into the firebox, by which to produce the hydrogen to aid the combustion, I quote from the report then signed:

S. S. MONARCH.

Two tests trips were intended from Sarnia to Duluth on the Monarch only, but the weather became very stormy on one of the trips, and I left the Monarch at the Sault returning on the Campania, there bound for Sarnia, and the smoke records were continued by observing the smoke funnel of the Campania for comparison with the Monarch:

Smoke and Explosions

31

Monarch : No black smoke, generally greyish, thin and transparent.

Campania : Very black smoke, immense and dense in volume.

Monarch : At the worst rarely heavy dense or brown transparent.

Monarch : Smoke as described for intervals of 1 and 2 and 3 minutes.

Campania : Smoke as described for 8 and 9 and 10 and 12 and 15 minutes.

Monarch : No black smoke for 8 and 9 and 10 and 13 and 15 and 17 minutes.

Campania : Smoke all the time except for generally two minutes.

The officers of the Monarch, signed for the Monarch, also saying :

For the greatest interval of time between firing there was no smoke came through the funnel, only vapor.

At the time of putting on green fires there was a thin smoke for a few minutes, then for quite an interval there would be nothing from the funnel.

We, the firemen, went frequently to the side of the ship after firing, and the smoke was so thin that it did not seem to have as much body as burning wood ; in a minute or two after putting on a green fire, could see no smoke from the funnel.

The late Sir Henry Bessemer, who did so much for the World, when he was being entertained, after his successes, referred to slighted opportunities for great good, which he had suggested, and said that in his experience—that which was offered for nothing was valued at nothing ; and that test on the Monarch was one of those experiences in which I got nothing, nay more ; I had offered for the sake of a test to pay for the equipment in the furnace, and did so, and afterwards when out on the Lake, I had also to pay for my passage, meals and State-room.

After the two trips I saw what could be accomplished and took no further interest in the Monarch, though the equipment,

which had been too hastily prepared, with inefficient tools in a small town, needed attention to fit it for permanent use.

The season of Navigation was then about over and following Spring I ignored an invitation from the owner of Monarch.

Perfect combustion proved :

THE STEAMER CITY OF MACKINAC

A successful test under malicious conditions.

Subsequent to the tests on the Monarch, I made acquaintance of Mr. Frank E. Kirby, C.E., Detroit, and suggested that tests be continued at no cost to me, until the question of combustion and the abatement of smoke be accomplished.

I was very grateful to Mr. Kirby and quite willing to give my time at no charge to accomplish that desired end, but something prevented.

In 1891, when shipping men were preparing for the then coming season of navigation, the then Manager of the Detroit Cleveland Navigation Co., wrote to me to come on to Detroit about applying my invention there.

It was an exceptionally pleasant invitation, I was acquainted with Mr. James McMillan, who was afterwards Senator, and Mr. Hugh McMillan, and had done business with them in Scotch Plating Iron, they were the chief, I think the sole owners of that Steamship Co., and they were very likeable.

At Detroit, I made the acquaintance of the Manager, who in manner was like to the Messrs McMillan; it was a pleasure to serve such men.

The Manager said, we always consult Mr. Frank E. Kirby and Mr Kirby was phoned to come to Mr. Carter's office, where we again met about combustion.

To know Mr. Kirby is to admire him and to like him, besides being an eminent consulting engineer, he is a safe advising engineer, his aim in all his work being to promote betterment in his undertakings.

We went down to the dock and into the boiler room of each

of the Steamers of the Company, after looking into the furnaces of each Steamer :

Take your choice for a trial, he said, but I suggest the City of Mackinac because the Mackinac has two boilers, each in all respects the same with separate funnels, and if tests are made firstly in one boiler, the contrast can be seen with the other boiler.

The suggestion was a good one and the City of Mackinac was chosen.

The boilers were each 12' in diameter each with its own funnel, each having two furnaces 5' x 6' (30 feet). the Starboard furnaces only were fitted with the Livingstone fixings to perfect combustion ; the same stoker was to fire both boilers, the coal to be brought from the bunkers to close to the stoker for quick firing, the firing of the four furnaces : was one furnace after another in consecutive order commencing on the starboard side, and each firing at uniform intervals of time, in so far as possible.

The coal was good bituminous coal and the firemen were good stokers ; there were inimical and furtive acts from the first, but such acts were at the instance of their Chief, to defeat the test, a test which, despite his furtive interferences, every day the steamer was under steam, after the first trial, was the most effective evidence in 100 years that bituminous coal can be burned to a perfect combustion and the last trial was proof that the perfect combustion, of bituminous coal was accomplished, without sending smoke out of the funnel and without its waste as cinders ; the stokers were made by the chief to fire heavier on the Starboard side than on the Port side, to make the Starboard funnel smoke as much as the Port funnel, but failing in that, the chief then, as often as he could do so unseen, closed a valve cutting off the steam to the castings in the Starboard furnaces, causing smoke and creating a risk.

The theory in part on which I was sure to perfect combustion was to produce hydrogen in the furnace, to use the hydrogen in releasing the black smoke that is encysted in the flames, and to have the hydrogen in its higher velocity (6050 feet a second) than the other gases to overtake and unite with the particles of carbon in the furnace and consume the carbon monoxide, which is

always forming, as evolved, in that way eliminating smoke, depositing no soot and making no cinders, the carbon dioxide hindering the combustion of the carbon particles, as in ordinary way of burning, when the cinders pass to the front and through the interstices to the ashpan, the carbon dioxide white vapor (the gases evolved in the perfect combustion) pass unhindered to the funnel.

I used hollow castings in the furnace, protected from burn by the steam passing through them, the castings fixed at one side of the bridge wall and connected with each other by a valve and with the steam in the boiler by a pipe. In the castings were small screw plugs with effective small holes in them from the hollow inside to the face of the castings—where they faced the radiant heat of the fire; the hydrogen was produced in the castings and as the steam passed through the plugs, the hydrogen which is also the highest in diffusion 3.83 to 1 for air and 1.1 for carbon monoxide, the latter gas was consumed as formed without depositing soot, not clouding the atmosphere with smoke and the draft carried out only the invisible incombustible carbon dioxide and white vapor.

The first and second trip was experimental to see if there was room in sufficiency in the castings to produce the hydrogen, another and another set of castings was added and connected to obtain the results in the report of the tests; one of the furnaces lacked one casting to be the same as its mate furnace.

The result proved absolutely beyond a question, that it was possible to burn bituminous coal without making smoke, and without loss in the ashpan, other than as spoken by a stoker "there is nothing but the dirt". Meaning as seen by me and Mr. Howland of Toronto with his friend, who were tourists on the steamer, and seeing me making notes on the upper deck, after expressing a desire to look into the furnace, we went down into the boiler room; at their request the stoker opened the furnace door, and they saw the fire at the white heat; in looking at the waste in the ashpan, the stoker made the remark—"There is nothing there but the dirt".

That remark did not refer to combustible cinders, it referred

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to the incombustible waste in the coal, which had fallen through the interstices ; it was not wasted carbon as hereinbefore referred to in tests on the Erie Railroad ; by the removal of the carbon dioxide as produced, that gas had not hindered the burning of the carbon monoxide and carbon particles, the "dirt" was seen in the ashpan to be "dirt" only, not combustibles.

When looking into the furnace the boiler had commenced to blow off, and the firemen were made to shiver from a shout by the Chief yelling "What the H... do you mean by letting her blow off"

There was less difficulty in making steam than in keeping the pressure down, hence the blow off, which was not the first time, but it was then an excuse for that chief to swear, it was an excuse to remind the firemen that he was the chief ; he was a successful swearer, making men afraid.

On one occasion, when I was making notes on the upper deck watching the funnels, there passed from the Starboard and Port boiler funnels an excessive volume of black smoke, I wondered what had caused it and as it was repeated more than once I went down to the fire-hole, and as I put my foot out from the ladder, I stepped into wet coal mush ; the coal required no selecting, it was good ; but at some trouble, dust had been selected from the bunkers, the dust was moved to beside the stoker, the hose was turned on and the coal dust was made like to the consistency of porridge, and so fired into the furnaces, to give me a dose of smoke on the upper deck.

At the time I landed in the fire-hole, the then fireman was coming off his watch, I talked seriously with him, the 2nd Engineer tried to make a scapegoat of the stoker and to pass the trick over as a joke to give me a dose of smoke on the upper deck : the stoker would not be the scapegoat, he said it was not his fault and that he would let them see that when he would go on his next watch, he would fire fairly and he did.

FAIR FIRING BY ANGUS THE SAID STOKER

Smoke as seen at the funnels.

Right hand Starboard Furnace ;

This furnace was clean always after each firing, there never more than a thin grey, so thin as not to be worth mentioning.

Left hand Starboard Furnace :

This furnace was incomplete two castings, after each firing showed freckles of darker grey and in more volume than right, but the whole disappeared like a puff leaving no distinguishable fraction of time to mark the duration.

Port boiler furnaces :

These furnaces were fired much cleaner than on the previous watch, the evidence of good firing was apparent in the improved conditions at the funnel, but notwithstanding the smoke black and though in less volume it lasted from one to three minutes after each firing.

In contrast to the Port boiler funnel ; Angus kept the steam steadily up during the whole of his watch, and during that time (3 hours) there was neither black nor brown or even a dark white smoke worth mentioning from the funnel of the Starboard boiler. I could not for over two hours mark a period of time after each firing that there was any dark smoke, for of black there was none and of what that there was of a greyish color, I could not turn my eyes to my watch quick enough to get its duration before it was gone as a puff.

During the firing by Angus, one of the other firemen came up to the Upper deck and watched for a long time with surprise at the clearness of the funnel. I think he watched for nearly an hour, then he went down to the Main deck and another Stoker went up, he also watched the funnel for about an hour. During the time those Stokers watched they frequently said : "My Angus is doing well, the firing is wonderfully clean, nothing to be surprised at the funnel when Angus fires the right hand furnace and only the required casting in the other furnace to make the Starboard boiler perfect.

When I went down from the upper deck I asked the Chief how Angus had kept his steam ? He said :

That he had kept the pressure steady all the time.

Notwithstanding, the Chief was inclined to destroy the ca

ings, I had asked him several times to forget that they were in the furnace, that they required no attention, but the aborting of the test was his study :

On one occasion he went down to the fire-hole, he did not know I was near him, he closed a valve cutting off the steam to the castings, after a time, sufficient for the iron to cause a disrupting temperature that would disrupt the steam, he reopened the valve, and he got a fright ; the expansion from the disrupted steam threw the burning coals out of the furnace, aside from which he jumped with fear and, seeing me, he said he had closed the valve, then opened it a little, and a little more when it threw the live coals out of the furnace, giving him a fright. I told him I was glad of it, that he might not again touch that valve, as it was dangerous for him to do so.

He probably thought that what was safe for me was safe for him, for he continued his devilish tricks.

In all the years since and all over America, there has been no attainment equal to that on the City of Mackinac without producing smoke and cinders.

On the trips of that steamer in the month of May, I had paid for my transportation, state-room and meals, the Manager of the Company on learning that I had done so directed the Purser to refund all I had paid, which he did ; and he informed me that he was directed to put of record, that I was to have the right to travel free, all the season,

I liked that, because it was equal to acknowledged satisfaction.

Notwithstanding, the Chief, a Scotch crowl, furtively and stealthily, persisted by malicious acts, chiefly by closing a valve to abort the desire of the manager, and to defeat the orders of one of the most respected Consulting engineers on the Continent.

It may be asked, why I now bring this matter up 21 years after ?

The wronged never forget. I am 21 years older than at the time of that test. The public have since craved for relief from smoke, and the Nation has groaned under the multi-millions of dollars wasted in imperfect combustion.

To have aborted a success, which would have been a gain to

the Detroit and Cleveland Navigation Co., a relief to the public and a saving of millions of dollars to the Nation was a crime, but that test is not fully told :

THE STEAMER CITY OF MACKINAC

Continuation of the test under malicious conditions :

Stoker Angus, had vindicated his name as a man who dared to fire fair, and in firing fair, he had made absolute proof that bituminous coal could be fired without making smoke ; but the other stokers had fired as well except that I had accidentally caught them putting and they admitted that they had put, extra shovels of coal, by order of the Chief into the Starboard furnaces, notwithstanding, their firing was so perfect that there was no measure of time of sufficient duration to enable me to look at my watch before it was dissipated like a puff.

After that trip of the Steamer Mr. Frank E. Kirby directed that as in that experimental test, there were more than two castings in each furnace, that one larger casting of sufficient capacity be got ready for each side of the bridge-wall in the Starboard boiler, and that the same be got ready for the Port boiler, and he directed his man to see to this :

That was done and in the trip that immediately followed their installation in the Starboard furnaces, there was again proof that bituminous coal can be burned without making smoke, there was satisfactory evidence, satisfactory evidence of perfect combustion.

On the night of that trip I stood on the upper deck when the Chief's Assistant, he was called the Greaser, came up to grease the walking beam, after greasing the walking beam, he turned to look at the funnels, he said : If, Mr. Livingstone, you have not got perfect combustion, no one ever got as near to it. He was an observant, honorable man, his opinion was good.

The deck hands remarked in a head wind, that while there was coal grit on the Port side of the deck which they were continually sweeping, there was nothing on the Starboard side worth mentioning.

Even the Chief could not deny that the smoke nuisance was

eliminated at the Starboard side and that the pressure was maintained steadily, but grudging that fact he said it was due to good firing, he cared not that that statement was illogical in that the Port funnel was sending out bulky volumes of smoke and cinuers and the Starboard funnel about only vapor

When the steamer left on her next trip, I remained in Detroit to hurry the castings for the Port boiler, I had no fears about the Starboard boiler, I had no fears that it would ever again send smoke out of the funnel, whether the firemen were the same or others firing as ordinarily.

I had told the Scotch cowl that Mr. Kirby had ordered the castings to be got ready to put into the Port boiler, and witnessed the effect in the Chief, by a sudden nervous twitch, which should have warned me ; but I was not born a suspicious man, and that warning failed to make me one.

On the 27th of June, after the described successful trips, the second time after the installation of the large castings for a permanency, I met the Chief on the dock, and pointing to a casting beside an Electric light pole, he said, look at that? Jack broke two cold chisels cutting that out.

Jack, was the 2nd engineer.

Why, I said did you cut it out ?

He did not then say why.

That casting, I said, would not have burst if the steam was *not* shut off.

Did you, I said to the Chief, shut sff the steam ?

To me the incident was a shock.

Jack the 2nd engineer would not have cut the casting out without an order from his Chief.

I questioned a fireman as to why, he said :

I dont know sir.

There came a time when I did learn that that Chief did not want, and was determined to prevent, the success which the manager of the Company and Mr. Kirby desired; the steam in the castings had been sufficient to save them, and as I had prevented his efforts, by closing the valve, to cause failure, he resorted to the cold chisel to cut the casting out, when I was not on the

ship, having as aforesaid remained in Detroit to get ready for the Port boiler.

Mr. Kirby happened to turn up when I was standing over the casting.

To a pleasant conventional remark about what I was doing, I answered by pointing to the cut out casting.

What caused it? he asked.

If the steam had not been shut off it would not have occurred I said, unless there was a flaw in the casting.

Have the casting he said, sent to the Dry Dock Engine Works, and get Donaldson to split the casting as he would split a block of wood, and if any flaw in the casting it will be seen.

The casting was split by Donaldson, and no flaw was found.

That same evening just before Mr. Kirby came on the scene the Chief of another of the Steamers of the Detroit & Cleveland Navigation Co., in passing to his ship said to the Chief of the City of Mackinac :

"Well Mac. you have done it.

"Yes, said Mac. it is bursted.

"I am damned glad of it ; smoke, why, I have sent not only smoke but red hot flame 8 and 10 feet high up out of the funnel."

"Did you, I said, say you had sent red hot flame 8 and 10 feet high up out of the funnel."

"Yes, he said, 15 and 20 feet high."

It was not easy to account for the hostile attitude of those engineers their menace was very unpleasant to me.

I had a suspicion that the Chief was mad that he had not been consulted by Mr. Kirby before ordering such a test, for he was most offensive to the steam fitter who went down into the firehole to do the work.

In violent speech, what the h... are you doing there was his address to the steam fitter, when he heard the sound of his hammer, and he kept on swearing, making the steam fitter afraid.

The Chief of the other steamer after his said unwise words told his grievance that Mr. Kirby was bothering him with some improvement to deliver fresh air into the Dining room and into the boiler room, the latter for the benefit of the stokers.

The Chief, though he behaved infamously, desired to keep my good will and when with him in the Engine room he assured me that he was my friend. He also informed me that on one occasion a man came to him with a request from Mr. Kirby to have something tried that that man wished to have introduced, that he did try it, and that that man "never as much as gave him a \$5. bill, ' but that he got even, he fixed him ; as he may have said since about these tests.

On every trip of the Steamer I went aboard with boxes of cigars, none of them smoked by me (I dont smoke) and the treatment I received is herein told, the 21 years since have been as one day, thinking of the infamous burking of the only successful tests in the World's history to abate smoke, and terminate forever the enormous waste of fuel.

Prior to the cutting out of the casting, the evening after the return to Detroit, after combustion had been absolutely assured, we walked up Woodward avenue and entered a nice Cafe, where I told the Chief to order what he pleased, and I directed the attendant to bring the best cigars.

The waiter brought the best cigars, large ones, the Chief looked at them and asked the price.

The waiter said \$1 each.

I wont smoke them, the Chief said, my tobacco costs only \$12 a year.

I have done my share through life in tips, but to pass from acts of generous kindness to graft, would make my face burn crimson.

Not having taken the hint from his tale of the man "he fixed" because he "Never as much as gave him a \$5. bill", though it was my intention to be generous at the proper time, he was not disposed to be friendly, not disposed to smoke \$1 cigars, he preferred the coin, and as that was not voluntarily offered instead of cigars, he brooded on the way to fix me, with the said result in—the cut out casting.

On the 4th of July I was again on the Dock after the arrival of the Steamer, a friend was with me, we met the Chief, who asked what had been done with the bursted casting, I told him :

That it was split open by Donaldson, that the metal was found to be good, that it was apparent beyond a doubt that the steam had been shut off, and turned on again when the casting was burning.

Then the Chief made a statement which contradicted what he had said on June 27th., he said :

"The steam was turned on by myself on the 20th. I had been away and came down, it was about six o'clock standard time when I came down and turned the steam on, the fires were burning at the time. The steam was turned off too at the end of the trip, I turned the steam on the next morning."

"Why had the steam been turned off ?"

"I dont know, he said.

Mr. Kirby had desired to see how the other castings in the furnace were standing the heat, the steam being supposedly in them.

To my question, he said :

"I have not been able to see them on account of the fires, but suppose they are all right, though I cannot tell as the fires have not been drawn, there has been no steam going into them the last two trips.

Then by way of excuse he said :

"When Jack cut out the casting he cut it out from above the Globe Valve and for that reason steam could not be kept on the three castings that remained in the furnace.

The Globe valves, I said, were there specially to shut off connection to each or any of the castings, without disturbing any of the others, when necessary to shut off steam.

Why did he not close the valve to that casting instead of cutting it out.

With the look of the hypocrite dissembler, he said :

"It would have been better."

After it was seen that there was no further information to be had about the endurance of the castings with steam in them, Mr. Kirby asked me what I would advise him to do ? and said, he would to it.

I did not wish to be the cause of his dismissal and said so,

I said also that some of the engineers of the Company were so closely in touch with him, as seen in what Sargeant said, that his dismissal might cause resentment, notwithstanding his misconduct was infamous.

He had destroyed the casting, and by cutting it out above the Globe Valve, he had destroyed the other castings, he had defrauded the Manager and Mr. Kirby of their superior right to test the question of abating the smoke nuisance, with savings to the Company, and he had wronged me.

I, however, had evidence of the enduring quality of the castings with steam in them; two of the smaller castings having been in the hottest part of the furnace from May 16 until June 20, when they were taken out to make room for the large permanent casting, which he had cut out as aforesaid.

Meantime the castings for the Port boiler had been got ready, and the 2nd engineer hearing this, said, dont put them in until the boat is laid up for the season, and later two of the firemen said "You had no show, you were not to have any show", and that notwithstanding the Greaser had said, as Aforesaid: "If Mr. Livingstone, you have not got perfect combustion, no one ever got as near to it."

And in the 21 years since, during which I have travelled on Steamers and on Locomotives, observant at the same time of the chimnies of Stationary boilers, no one, absolutely no one, has got as near to it, and as my observations have extended from Canada through the States to Arizona; from El Paso through the towns of Mexico, where there were Railway Shops and in the towns of Cuba where Railway Shops are located, and seeing everywhere smoke and cinders, and having made a study of the way stated to perfect combustion, I can say with the same force as if under oath that not only were the tests on the steamer City of Mackinac proof that perfect combustion is possible as an every day matter of course—they were perfect combustion, despite infamous interference; and with the further experiences I have had in the past 21 years, they made proof that perfect combustion can only be accomplished with hydrogen produced and burned in the furnace, for only with the hydrogen can the carbon monoxide be consumed.

The inventors in the past 100 or more years have hardly considered the essentials to the union of the combustibles with oxygen, the velocities and rates of diffusion between the gases; their inventions have been only manual contrivances displacing one after another, but the laws of matter and the laws which govern the combustion and diffusion of the gases were made by the Almighty and they are unchangeable.

On that 4th of July when the Scotch crowl said "there has been no steam going into them the last two trips", the words came to my ears with my feelings, though held in subjection, in a strained tension, and I walked up Woodward Avenue so weak that a child could have pushed me over, so stunned that I might have committed suicide without being able to leave a clue for a Coroner to determine the cause.

On that purposeless walk, in stupefaction, bound for no place, I landed in my room and laid me down in my bed, instantly falling asleep.

Hours afterwards I awakened, and was again in Woodward Avenue, in full possession of my faculties.

Sleep is man's best friend.

Macdonald, the Chief, the sly Scotch crowl, had so disgusted me that I never wanted to again see his face.

But I had a desire to make one more test on the endurance of the castings in the furnace with water or steam in them.

D. P. Mackay, President of the Sun Company on Woodward Avenue, was summonsed at that time and fined for maintaining the smoke nuisance by causing smoke to issue from his chimney to the injury of a Hotel, and in scattering cinders in the Cigar room of the Hotel, and over the Show case.

I offered to put my device into his boiler at my own expense to better his combustion and leave no smoke or cinders to annoy the Hotel or any of his neighbors. I made that offer to test the endurance of the castings in the furnace. My offer was accepted. I put in castings with jets as described for the castings that were put into the City of Mackinac.

I was successful without experimenting.

The fine imposed on Mr. Mackay was remitted; the Hotel

was satisfied, I called on the man in charge of the Cigar shop of the Hotel, and on the Hotel folks, asked them if they were being annoyed with smoke and cinders from the Sun's chimney?

They said, not now, the Sun has put in a smoke consumer. Smoke consumer is a misnomer.

After a time I left Detroit, so greatly depressed, that it is a wonder I did not commit suicide.

Under date of Oct 21 1891, 115 days after the castings were put into the boiler of The Sun Company, I had a letter from Mr. Mackay saying.

"I have just had a conversation with Mr. E. W. Simpson, Building Inspector, whose card I enclose herewith. It would seem from what I can learn that now would be a very opportune time for you to push the smoke preventer in Detroit as complaints are being generally made about the smoke nuisance and something must be done on the part of Manufacturers. I showed Mr. Simpson our machine and he is delighted with the basis of its construction and theory of operation. Hoping this will find you well

Yours truly,

D. P. MACKAY,

I had not got over my experiences with the city of Mackinac, and did not go on to Detroit, though I appreciated Mr. Mackay's letter; with those castings in the Sun boiler 115 days and never burst, I had no fear, and there was also further proof luminous coal can be burned without sending smoke and cinders out of the chimney.

Before entering upon another test I proposed a written discussion and the proposal was taken up by three superintendents of motive power.

The plan contemplated was described in U. S. Patent 829,871, by which to produce and burn hydrogen, by burning with it as an aid to oxygen, the particles of carbon, and with it burning the carbon monoxide as evolved, in the furnace.

J. E. Muhlfeld, then S. M. P. of the Intercolonial Railway, Canada. Mr. Muhlfeld was a good man, a good mechanic, and a

graduate of Purdue, an Engineering College. After correspondence, he wrote to me.

"You are theoretically right, but I am afraid we would have trouble with the coal we have here."

He suggested however that I get an order from the Hon. Minister of Railways, and he would make a test. As however, I am a Conservative, and a liberal Government was then in power I did not invite a refusal by asking the Minister of Railways for such order.

E. A. Williams, was S.M.P. of the Canadian Pacific Railway and Lacey R. Johnson, S.M.P. was associated with Mr Williams. They were good men, and good engineers, none better. After the discussion by correspondence, Mr. Johnson acting with Mr Williams, and I understood under the approval of Mr. McNichol replied "Worth trying."

Only those who have worked and studied an invention to attain a great object can appreciate the words "worth trying", though they meant no money for me, but much, how much for the Canadian Pacific Railway?

According to the Railway Statistics of the Dominion for 1911, the Canadian Pacific Railway expended for fuel for Road and Yard Locomotives \$8,961,530 an average of \$5474 for each of the 1637 locomotives in service, it was surely "worth trying" to reduce that excessive expenditure.

If the Canadian Pacific Railway Company have not been able to save at least \$4,000,000 on that outlay for 1911, the hinderers were not E. A. Williams, who was appointed to the Erie Railroad after it was proposed in the written order "worth trying", nor Major Lacey R. Johnson, Esquire, whose worth received the late King Edward's recognition making him Esquire.

Under their orders, but only after long delay, when a narrow firebox locomotive (461) was spared for the test "worth trying" to abate the loss from imperfect combustion and eliminate the smoke nuisance.

The conditions for test in 461 were not as favourable as the conditions on the S.S. City of Mackinac, 461 being a narrow fire-box and the coal to burn was so full of slate stone and iron, that

clinkers closing the interstices, hindered that highest measure of success that would have been sure with like coal to that which was fired on the S.S. City of Mackinac.

The device by which to produce the hydrogen had to be different, and the only place for that being at the sides of the narrow firebox, the disfavor of the narrow type of firebox locomotive was accentuated, and the good obtained was due to the diffusive influence of the hydrogen, obtained from scorings between laminated sheets, rather than any merit in the locomotive.

Prof. Goss, who has given more study to sparks and cinders than any one else, says in "Locomotive Sparks" in respect to the Narrow firebox type :

"The total weight of cinders and sparks passing the heating surface of the boiler of a locomotive increases as the rate of combustion is increased, and under conditions approaching maximum production may, in connection with narrow fireboxes, equal 20 per cent of the weight of coal fired."

The device occupied 7 inches by the length of each side of the furnace, which lessened the grate area 32.84 per cent.

The test therefore on 461 was under the disadvantages incident to a narrow firebox, further narrowed, no other room being available for the device, and no other locomotive being at the time available for the tests, and bad coal.

Those disfavoring conditions infer better burning of the combustibles in the furnace, while the interstices were open; and loss of pressure, when the clinkers accumulated over the interstices, were natural consequences from the clinkers closing the interstices and shutting off the oxygen, the loss of it hindering the free combustion of the solid fuel on the grates, and the free union of the hydrogen from the device with the carbon monoxide above the grates ; notwithstanding there is very positive proof of perfect combustion, abatement of smoke, and a large saving on the sparks and cinders, which are a large part of the 50 per cent of the fuel wasted.

Comparative proof of saving will be made with the result of a test made on a Purdue locomotive used by the Purdue Engineering University for tests :

Smoke and Explosions

The Purdue locomotive had a 17" x 24" cylinder and was run light.

The C. P. R. locomotive 461 was run with freight at 175 lbs pressure and under.

The Purdue locomotive was run light at 130 lbs pressure.

The C. P. R locomotive 461 had a 17½" Cylinder.

TESTS OF LOCOMOTIVE 461 OF THE C. P. R. R.

With C. P. R. men.

John Wishart : Master Mechanic and Locomotive Inspector.

Arthur Gilmour : Maker of the device.

Stephen Smith : Engineer on Locomotive 461.

James Bell : Fireman on Locomotive 461.

All good men.

Miles

1904

July 4. Steam up.

5. Blew off steam to caulk a staybolt.

6. All day with steam up, on the track.

7. Round trip of Locomotive and Tender to Vaudreuil. 48.

8. Waiting all day with steam up for freight to haul.

9. Trial run with 709 tons of freight 128.

10. Trial run back with 1109 tons of freight. 128.

On arriving back at the Outremont Round House, Mr. John Wishart for the C. P. R. said, I want to see that front end opened to see what cinders are there, for if not there they were burned in the firebox.

Wishart, Gilmour, Smith and Bell, accordingly got up and opened the front end. Smith brushed up with his hands, all he could find, and holding up his hands, he said two fistfuls, put them back. 2 Fistsfuls of cinders in 304 miles, put back. There were air screams in the ashpan, 4 sides. I objected that the air was best when most dense.

1904

14.

The screens at the sides and back were closed at my request. When this was being done it was noticed that the boiler tubes were clean. No soot.

Trial trip with 797 tons of freight.

128.

Mr. Wishart at Vaudreuil telegraphed his satisfaction. The closing of the screens was followed by bettered steaming. That was 24 miles from Montreal. But at 87 miles from Montreal the clinkers covered the grate. The clinkers were lowering the pressure and robbing the furnace of its heat ; the clinkers were dug out.

July 15.

Trial trip returning with 1340 tons

128.

At some miles from the starting town of Smith Falls a Coupling broke, dividing the Train in two ; that caused re-coupling. 21 miles further on, six cars were laid off, and one other car was coupled ; tonnage 1034.

At the end of that trip, the front end was again opened to search for cinders, but Arthur Gilmour searched in vain ; there was only the same two fitsfuls found at the end of the 304 miles.

The closing of the air screens at the sides and back proved my theory that the air was best when most dense, by bettered steaming en route and by absence of cinders at the end of the 256 miles with the air screens so closed.

And when the device was being taken out of 461 at the Shops in Delorimier Avenue, with intent to be placed in 1212 at the Angus Shops, it was found there was no soot in the tubes ; that was proof that the hydrogen from the device had consumed the carbon monoxide, and had caused bettered combustion and steaming.

And during the time of travel over the said 560.

miles Mr. Arthur Gilmour aforesaid, an observant man and a good mechanic, feeling interested in having made the device, sat on the top of the Cab of the Locomotive, a good part of the time of each of the said trips, he smoking his pipe or a cigar, not bothered with smoke from the smoke Stack.

And during the time of the said trial Mr. John Wishart, an observant man, very observant on that trip, was so pleased on the 14th that he telegraphed his satisfaction from Vaudreuil to Montreal, and was only disappointed when clinkers caught up to and covered the interstices, causing the pressure to be lowered, that however was chargeable to the character of the coal.

Stephen Smith, Engineer, and James Bell, Firemen, were on the watch all the time, they were good men, ceaselessly observant and all the time appreciative, though the labor of taking the clinkers out of the firebox devolved on them.

As the public were interested in the success of that test, though the people did not know about it, those men deserved the thanks of the public and the Railway, for their fairness in their labor to solve the problem, the smoke nuisance, which so many have tried unsuccessfully to solve, notwithstanding that the public have suffered for over 100 years.

Because of the annoyances with the coal, I desired to have one final test with good coal, even though it might be a special purchase, but a stranger was in the place that before was occupied by Mr. E. A. Williams; unfortunately the stranger was not in sympathy with the test for the abatement of smoke, being an egoist, that was too much to expect, but as I was under his jurisdiction, the order had to come from him.

He was candid in saying;

"The coal is bad, it is the only coal we have, it is the only coal we will get."

Not being able to get good coal for a final test, I asked that an order be issued by him, to have the device taken out of 461 at Delorimier Avenue, that it be delivered at the Angus Shops for installation in 1212 a wide firebox engine, to give the men a chance to push the clinkers aside as they accumulated.

That request was also refused, and he said .

"Why do you come bothering the Railways? Go to the Stationary boilers which make the smoke."

After further appeal, and information to him, and after referring to the circumstances under which the test was entered upon, not hastily, but only after long consideration, and after quoting Mr. J. E. Muhlfeld, as one of those who had studied the question and discussed it, and after getting a written opinion at my own expense for his information, from McGill University, about the production of hydrogen in the furnace, which he doubted, and after giving him an extract from Mendeleef, and information on the same from experience on 461, he promised to issue and did issue an order as so requested, but after that was done, he objected that 1212 required a new grate, that it would cost \$75 and he would not spend that, that the tests had already cost about \$300 and he would spend no more.

Mr. Stranger was a likeable man, but an egoist, except as the product of his brain, he could take no pleasure in it, I did not however try to impose that device on the new official as has been unjustly said—by way of excuse for his arresting the said tests; after that final test, which would have been as under the orders of his predecessor, he would have been free to do as he pleased.

Being an egoist the new official could only think of the said tests as of no pleasure or advantage to his personal interest, his egoism required personal gratification; in his mind, his was the only mind, he had no need to see the tests between Montreal and Smiths Falls, no matter existed except as in his mind; in his position at the head of the motive power department of the Canadian Pacific Railway, any good that might be in the tests must fade, his interest was in himself, not in others, he was not altruistic, the desire to test the perfect combustion of the coal was not his desire, some one else ordered, it was his desire to smother it.

Time has not discovered good, but harm, in the egoism that begat the desire and purpose in him to suppress the said tests.

SUMMARY OF PROOFS.

There is in the said tests proof that bituminous coal can be

as it was, burned without making smoke, otherwise Arthur Gilmour could not have sat on top of the Cab of the locomotive, without getting smoke and sparks in his face, without sending the poisonous carbon monoxide through the tubes for if not burnt in the furnace, as it was, it would have coated the tubes with soot, and if the carbon dioxide had not left the furnace in the draft, it could not have removed the soot, if any, from the tubes, and if the carbon monoxide had not been burned in the furnace, 461 would not have run the said 256 miles without showing smoke, dropping cinders in the front end and sending sparks out of the stack, and considering the velocities of those gases, their perfect combustion could not have been without the hydrogen, produced and united with the oxygen in the furnace, and with the carbon in the combustibles.

The actual cinders in the front end of 461 after 560 miles of travel with bad coal, hauling freight, was as aforesaid only TWO FISTFULS, all in the 304 miles ; none in the 256 miles.

The coal was not weighed and the weight of coal cannot be quoted, but it can be estimated at much more than on a Purdue locomotive of about the same size, which in running light for estimates of waste by sparks and Cinders, burning Brazil block coal, the best bituminous coal in the U. S. A., burned 11,350 lbs, and had therefrom 1098 lbs of cinders and sparks.

Despite the bad coal in 461 the hydrogen had consumed the combustibles.

COMPARISON

C. P. R. Locomotive 461 in 560 miles with freight had TWO FISTFULS, of cinders.

Purdue Locomotive burning 11,350 lbs, with Tender only, had 1098 lbs cinders.

Making proof that the combustion in 461 was as near as possible perfect, whereas the better advantaged Purdue locomotive running light, produced in sparks and cinders about 10 per cent of the coal fired.

TWO FISTFULS OF CINDERS

Under the conditions of burning the bituminous coal in a run of 560 miles hauling freight, the results aforesaid, as information, are evidence, that it is possible to burn bituminous coal without making smoke.

There was no excuse for the waste as sampled by the Railroad Companies at Chicago, giving out 43 per cent of the smoke made in Chicago, no excuse for discharging 560 tons of cinders within the city every day in the year ; no excuse for those conditions in any city.

The freedom from smoke and cinders could have been assured in the staying.

There was no excuse for Marine boilers, properly installed, as in the Steamer City of Mackinac, making a nuisance with smoke and cinders, as in the case of the New York Edison Electric Light Co.

There was no sufficient excuse for a smoke nuisance from Stationary boilers, as seen in the case of the Detroit Sun Co., which promptly ceased to be a nuisance and obtained a remission of the fine imposed by the Civic authorities for creating a nuisance.

There is no sufficient reason for the deposit of 76,050 tons of soot in London, yearly, if the steam boilers there are installed to produce and burn hydrogen ; nor necessity for the soot or smoke that rises from the grates in dwellings, if the grates are so designed that the oxygen of the air can intermingle in attenuated streams with the smoke in the flames above the grates, before they are cooled in distance above the fire.

The said test proved that it was "worth trying", and it proved the advisability of an improvement in the device I then used, that would not rob the grate of any part of its room: I have since accomplished that.

The time since, and the time back for over 100 years, in which perfect combustion has not been accomplished, makes proof that only in the way indicated by the said tests in the summary, can perfect combustion be assured.

Four witnesses live to prove that only two fistfuls of cinders

were found in the front end after 304 miles of travel and one of them sat on top of the Cab of the locomotive without being smoked ; and that one witness is alive to prove that after closing the screens at the sides and back to better the draft, there were no cinders (except the two fistfuls) in the front end after 256 miles of travel as aforesaid; and that witness (Gilmour) sat on top of the Cab of the locomotive looking for smoke, undisturbed by smoke.

That was absolute proof that the carbon monoxide was burned ; if produced in imperfect combustion, though a combustible gas, it would have left the furnace, the air could not overtake it, the tubes would have been coated with soot and the Smoke Stack would have given out the carbon monoxide with its constituent 42.86 per cent of carbon, which not being in union with oxygen, the other constituent, the constituents of carbon monoxide not being in combining proportions, blackens the air after passing out from the smoke stack, and the loss in fuel continues even after the firebed is red, and the production of the carbon monoxide continues, though invisible, passes out as the poisonous gas, except when overtaken by hydrogen as aforesaid, the hydrogen, oxygen, and carbon then burning in a perfect combustion.

WHAT THAT MEANS FOR THE PEOPLE?

That is answered by an extract from a speech in Cincinnati, Ohio, by Mr. Herbert N. Wilson, Chief Engineer in the United States Geological Survey: "The smoke nuisance is one of the greatest dangers of modern times, insidiously attacking the health of the individual lowering its vitality, increasing the death rate, and causing untold loss and injury to property."

"The damage which this evil inflicts can hardly be estimated in money ; it is equally impossible to estimate the amount of suffering, disease and death, and the general effect of lowered vitality caused by the nuisance."

"A careful inquiry was recently made by the Government of the U. S. A., concerning the toll paid by the people of the United States on account of smoke. Unfortunately, but few cities have investigated the costs involved, but those which have, furnish data

that are almost startling. Summing up the results of enquiries in a number of cities, the estimate is made that smoke causes more than \$500,000,000 in damages each year in the destruction of merchandise, the defacement of buildings, tarnishing of metals, injury of human life, greatly increased labor and cost of house-keeping, and the losses of manufacturers due to imperfect combustion."

"Dr. Fisher in his report to the National Conservation Commission on the subject of human vitality, states: It is found that 15 years, at least could be at once added to the average human life, by applying the science of preventing diseases; more than half of this gain would come from the prevention of tuberculosis, typhoid, and five other diseases, the prevention of which would be accomplished by purer air, water, milk."

"The prime source of the pollution of the atmosphere is smoke."

"Turning to the losses in fuel combustion:

"Our present method of burning coal with smoke is costing the people of this country, unnecessarily, \$90,000,000. It is estimated 8 per cent of the coal used in the production of power, light and heat or about 20,000,000 tons of coal are going up the chimneys each year in smoke, at a cost of at least \$40,000,000. It is further estimated that in the production of coke 25,000,000 tons of coal are wasted in the air. This coal is worth \$50,000,000.

"While this total loss of \$90,000,000 due to imperfect combustion, added to the losses due to damaged property, aggregates a vast sum, it is as nothing compared with the injury which the smoke inflicts on life in the great cities."

What smoke costs in reduced vital energy is shown in the figures given by Rollo Russell, who estimates that the shifting pall of smoke which hangs over London, costs Londoners as much as \$25,000,000 a year. It is estimated that owing to the perpetual haze lying between Sun and city that London gets only 50 per cent of the Sun's light between November and February and only 84 per cent from May to August."

"Sir Frederick Treves, a famous physician, said that in three

days of fog in Manchester, it was calculated that for every square mile 150 lbs. of Sulphuric acid and 1300 lbs. of soot were deposited. A similar examination in Chelsea showed that for every square mile there were six tons of soot."

"Sir Frederick Treves said that from what he had seen of the lungs of persons in London, they were absolutely black on their surfaces and down to their depth. He declared that smoke killed people not by scores but thousands."

"It must be understood that smoke, is one of the most poisonous gases polluting the very air we breathe. Medical men the world over agreed that the breathing of coal smoke predisposes the lungs to tuberculosis and to even more violent lung troubles such as pneumonia, as well as to many other acute diseases."

"In its investigations the U. S. Geological Survey has found that the chief waste in coal is due to imperfect combustion in furnaces and fire-boxes."

"As the coal burned is a considerable item of expense, averaging about 30 per cent of the cost of producing power, there is more opportunity to save in the boiler room than in the engine room."

Referring directly to the Railways and especially to the U. S. Railroads, because the Interstate Commerce Commission's Reports are convincingly correct, it is seen from those reports that :

The fuel expenses of the U. S. Rys. in 1906 was				\$170,499,133
"	"	"	"	1907 " 200,261,975
"	"	"	"	1908 " 201,905,054
"	"	"	"	1909 " 188,735,868
"	"	"	"	1910 " 217,780,953
"	"	per U. S. locomotive		\$ 3,651
"	"	of the Canadian Rys. in 1911		" \$ 20,182,103
"	"	per	" locom've "	" 4,705

is not an exaggeration to say that of those expenses amounting to \$1,000,000,000, 50 per cent is wasted in the production of carbon monoxide and otherwise as hereinbefore indicated; in other words \$100,000,000 a year in the imperfect combustion of the coal, a large part of it may be in incombus-

tibles in the coal, paid for as coal, but as burned, there is a loss of 50 per cent on the combustibles to the Railways of the United States and Canada ; C. W. Siemons said as much (as aforesaid) for 1872 ; B. H. Thwaite F. C. S. said as much ; and others have said the same.

From a Newspaper clipping I quote :-

"Chicago, Nov. 30.—American Railroads lose \$50,000,000 worth of fuel a year and consume \$200,000,000 worth of coal to obtain \$80,000,000 worth of efficiency, a further waste of \$120,000,000 worth of fuel power according to figures prepared by Chief Engineer Fitch of the Chicago & Great Western Railway. That Road conducted an investigation as a result of the charges by Louis Brandeis that Railroads waste \$1,000,000 a day through inefficient service."

Sir William Ramsay President of the British Association for the advancement of Science said in an address this year :

"If the data of scientists are to be relied upon, twice as much coal is used to-day on the average in factory fires and no less than six times as much in domestic fires as is theoretically required for the production of the effects obtained."

"Smoke is evidence of waste." That is a self evident quotation from the said Sir William Ramsay. The following is another sample of waste :

Pittsburgh, May 15.—Prof. Benner of the University of Pittsburgh stated that from the lungs of a man who had lived fifty years in Pittsburgh. a quart of soot had been taken. He exhibited the soot. In a cubic mile of atmosphere in Pittsburgh, the Prof. added, there were four and three quarters tons of soot."

Contrast that with "Two fistfuls in 560 miles."

Contrast that with no soot in the flues in 560 miles.

"Pittsburg, November 4. At 8.15 this morning the Sun was shining ; at 8.20 darkness settled like the twilight of an evening ; at 8.45 the blackness had spread like a black blanket over the city, and at 9 one could not see across the street despite the thousands of lights that burned ; Prof. Brashear said that as soon as he saw the cloud dropping he went to the

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Allegheny Observatory, 1,300 feet above the sea level, and observed the black mass slowly settling over the valleys, in the centre of the dense blackness appeared a wedge of a lighter cloud, which seemed to split the darkness in halves, the thick end of the wedge coming from the sky. He also said—It is a notable fact that each drop of rain carries with it whatever dust, dirt, grime with which it comes in contact. The soot and dust were thus collected by the rain cloud as it approached, forced ahead by the wedge of light which represented the stronger atmosphere. The rain fell in a torrent for a short time, carrying with it to the ground the suspended grime and the atmosphere was cleared immediately."

I remember a week I was in Pittsburg in which I awakened in the morning with a cough, I coughed during the day, and I went to sleep coughing, let all men think of the contrast in that experience with my experiences in a trip across the Canadian Pacific Railway through an atmosphere of absolute purity, with no smoke to be seen, except from its locomotives, in a travel over the prairies, and it should not be seen from its locomotives, for in perfect combustion it would give out the invisible carbon dioxide and white vapor which increases and brightens vegetation.

Prof. Benner, also said, in an address before the Board of Trade, "more than \$500,000 worth of laundry articles are destroyed every year by smoke in Pittsburg."

Ignorance, indifference, graft and egoism, will continue the wasteful, unsympathetic and heartless conditions for another 100 years if the governments of the World do not pass the requisite legislation to make criminal, the combustion of coal in the imperfect way by which life is shortened, the people injured, and the coal wasted, all being avoidable.

JOHN LIVINGSTONE.

EXPLOSIONS.

There is a cause, an irresistible fulminate from fire-heat and water with steam boilers under conditions which arrest conduction and circulation, a cause which some men in high places ignore, a cause for which trusted men conjure false reasons, and not many men understand the true reason, or care to know, lest in knowledge of the cause the existing conditions be disturbed, or lest there may be criminal responsibility for appalling disasters.

133,012 MEN IN DANGER ON DUTY.

According to the U.S. Report of the Interstate Commerce Commission for 1910, there were 59,654 locomotives, they were stayed with an average of over 1,000 staybolts and about 200 crown stays in each locomotive, manned by 64,691 engineers and 68,321 firemen, in all 133,012 men in the cabs of the locomotives, and relatively the same for Canada, which is being increased by an inflowing immigration of over 1,000 per day, and developed industrially as well as by the earth's increases, which have attracted the people of the World, and excited the desires of the United States.

In due time Canada will rival the United States in men and locomotives. The Railway world will come to Canada for Staybolts.

Men sell their services, not their lives, to be lost by explosion, and when their lives are taken someone is responsible and the Government is responsible, for nothing is done to assure safety to the men in the performance of duty.

The effects of the irresistible was seen in the Windsor Station disaster, it is seen in the foundering of the S.S. Titanic on her maiden trip with 2223 persons on board of which 1517 were lost.

Wherever the effects of the irresistible are felt, they are a warning wherever read, as in the foundering of the S.S. Cachepol off the west coast of Peru with 80 lives lost after the explosion of her boilers.

The effects were seen in the explosion of a locomotive boiler with the loss of 32 lives and 50 persons injured at San Antonio, Texas, U.S.A.

The excuse for that disaster, was cause of explosion unknown. It is since changed "to an over pressure of steam". both excuses were evasion.

The explosion of locomotive boilers are of so frequent occurrence that it is a surprise that the Railways are not awakened to a sense of responsibility and to a quickening in discovery to find out the cause and to apply the preventative to assure safety to the employees and public.

Previous to the days of steel for boilers, iron was the material used, sometimes for high pressures, the material was Low-moor iron or other high tensile iron, and the explosions in those days were often mere bursts, from lack of strength, there were however, disastrous explosions, no doubt from the same common cause as now, and the Low-moor iron was not a preventative, for the most violent explosions may come from boilers made of the best material, and at low pressures as well as at high pressures.

In the present day, the shell of the boilers endure a tensile strain of about 50,000 pounds to the square inch, and the stay-bolts the same.

In that tensile there is a reserve strength in the material for all the required endurance for steam pressures in the boiler, the maximum pressures being generally about 200 pounds to the square inch, as the pressure was in the boilers of the S.S. Titanic, which had a number of explosions, not from internal pressure in its boilers, but from water through its wounded side finding the heated parts of the boiler, which were unprotected, the inflow of the water from the wound made by the Iceberg, not the reserve power in the water in the boilers, by its contact with the heated parts of the boilers caused the explosions, which shortened the life of the great and magnificent S.S. Titanic, and broken in two by the explosions, it went to the bottom of the Ocean with 1517 lives.

What is the reserve power in the water in the boilers?

Smoke and Explosions

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Over 50 years ago D. Lardner, Doctor of Civil Law, Fellow of the Royal Societies of London and Edinburgh, of the Royal Irish Academy, Member of the principal European Societies for the advancement of Science, made a table showing the pressures, temperatures and volumes of the steam compared with the water which produced it, from one pound to 240 pounds pressure. From that table I quote for One, 90 and 240 pounds pressure, so that the reader may answer for himself the said question :

Pressure in steam per square inch in pounds	..	..	1
Corresponding temperature	..	..	103
Volume of the steam compared to the volume of the water that produced it	..	..	20,868
Mechanical effect of a cubic inch of water evaporated in pounds raised one foot	..	..	1,739
Pressure in steam per square inch in pounds	..	..	90
Corresponding temperature	..	..	324
Volume of the steam compared to the volume of the water that produced it	..	..	325
Mechanical effect of a cubic inch of water evaporated in pounds raised one foot	..	..	2,438
Pressure in steam per square inch in pounds	..	..	240
Corresponding temperature	..	..	403
Volume of the steam compared to the volume of the water that produced it	..	..	134
Mechanical effect of a cubic inch of water evaporated in pounds raised one foot	..	..	2,687

If the strength of the boiler permitted and it were possible to continue increasing the temperature, the volume of the steam might be contracted to the volume of the water that produced it, that however would not be practicable, material has its limits in strength and the equal volume could not be reached before the boiler would be rent asunder.

Smoke and Explosions

An explosion from the reserve of power in the water in a boiler is not to be feared, and it would not be of the fulminating kind, if it were possible, explosions from water and steam are misleading expressions.

There was a test on the 20th of June, 1912, to produce an explosion, in this the purpose was to advertise a different kind of boiler from the ordinary radial staybolt boiler; it was known as the Jacobs-Shubert boiler, I quote from the *Iron Age*, a reliable paper, dated June 27th, 1912.

"Both boilers were mounted in a field 50 feet apart and were operated from a bomb proof located 200 feet away from the nearest boiler, Oil was used for fuel, because it would have been dangerous for a man to have shoveled coal."

"Both boilers were the same in size and design, except that one had the Jacobs & Shubert Sectional firebox."

"Both boilers were brought to conditions of operation estimated to be 1,400 horse power."

"The supply of feed water was shut off but all the conditions remained the same."

"The water level gradually fell under control exposing the the crown sheet and other portions of the heating surface to the full effect of the fire."

"Under normal operating conditions, these surfaces are protected from overheating by contact with the water."

"In these tests the lowering of the water level deprived the plates of this protection and they became RED HOT."

"The boiler having the Jacobs-Shubert sectional firebox was continuously tested under these severe conditions for 55 minutes without developing any failure, notwithstanding the fact that the level of the water fell to a point more than 25 inches below the crown sheet. The test was then discontinued because the small amount of water did not evaporate sufficiently fast to supply the draft to maintain the fire."

"The ordinary radial staybolt boiler was then tested under conditions identical to above described."

"After the test of the ordinary boiler had been in progress

for 23 minutes and the water level had fallen to $14\frac{1}{2}$ inches below the crown sheet an explosion occurred."

"The crown sheet and the stays, which hold it in place, having become highly heated, pulled away from each other, and released the pressure in the boiler, the force of the explosion.....was sufficient to throw parts from the furnace in all directions for a considerable distance, and to lift the entire boiler, weighing about 40 tons, several feet above its foundation."

All the essentials to cause a violent explosion were prepared, the firing was to be done with oil to avoid the sacrifice of the men, the men were protected, bomb-proof protection, the supply of water was shut off, the crown sheet was made red hot, the water level was lowered to $14\frac{1}{2}$ inches below the crown sheet, and the explosion took place.

"The Jacobs-Shubert Sectional boiler carried between 215 and 225 lbs. for the first 27 minutes and gradually dropped to 50 lbs. at the end of the test, because the small amount of water remaining did not evaporate sufficiently fast to supply the draft to maintain the fire."

"The radial boiler carried 225 to 230 lbs. and was at 228 when the failure occurred."

The explosion of the radial boiler was a natural consequence of the provisions made to wreck that boiler to put it into contrast with the Jacobs-Shubert boiler which commenced to die after 27 minutes.

Suspending criticism. I refer to a discussion by able engineers, members of a Western Railway Club, on an interesting paper by M. E. Wells, on the question of low water and the overheating of the crown sheet:

W. E. Symons, Consulting Engineer, Chicago:

With reference to the crown sheets being overheated by excessive firing, for instance—with liquid or fuel oil, do you think it possible with a thin layer of water above the crown sheet level, say two inches or less, to expel this water from the area of the sheet subjected to the most intense heat, leaving it

exposed, resulting in this portion of the sheet becoming soft and coming down although the actual water level was above the crown sheet $1\frac{1}{2}$ or 2 inches?

M. E. Wells, the author of the paper :

Not with an inch or two of water on the crown sheet. You go into some mechanical library and you can find tests that have been made, where they have had different kinds of fires just as hot as they could make, and they have never been able to burn a piece of boiler plate with water on it.

W. E. Symons :

I quite agree with you that a crown sheet cannot be burned with water on the opposite side to receive and transmit the heat units. I am inclined to think you do not understand my question. Do you not think it possible to damage or burn a crown sheet when the water level is $1\frac{1}{2}$ or 2 inches above the sheet, this by excessive firing with oil fuel expelling the water from the sheet by generating it into steam faster than supplied?

M. E. Wells :

It might with a thin layer of water, but I doubt it.

W. E. Symons :

Say one inch !

M. E. Wells :

Possibly. Along that line Mr. Symons while you are thinking about that, think about the superheater pipes. They don't overheat, and there is nothing but steam in them. Mr. Vaughan in his paper before the Master Mechanics Association showed that steam could be superheated 500 to 700 degrees, and I don't know that they have had trouble with the pipes burning out.

Prof. W. F. M. Goss :

You can superheat steam right through iron without superheating it to the danger point.

W. E. Symons :

But, with a superheater it is never subjected to the intense heat that a crown sheet must stand from the use of oil fuel. Coal

has 14,500 B.T.U. per pound, while oil has 19,000 to 21,000, and with some types of burners can be and frequently is directed against a certain point or place, and it is claimed under such conditions, with the water level $1\frac{1}{2}$ to 2 inches above the sheet, that it is possible to force the water from portions of the sheet by violent ebullition, and keep it so exposed during such period of excessive firing.

M. E. Wells :

What would keep it away ?

W. E. Symons :

Excessive heat, high temperature.

M. E. Wells :

You must be constantly generating steam that keeps the water away : what is that being made of ?

W. E. Symons :

Being made of water.

M. E. Wells :

It forms steam ?

W. E. Symons :

Yes, steam and gas.

M. E. Wells :

As long as you are making steam that keeps the water away, there must be some water coming in to make the steam.

W. E. Symons :

Not on that portion of the sheet, it having been exposed by excessive firing and covered by a body of superheated steam or gas ; I ask the question, if in your opinion such conditions and results are possible ?

M. E. Wells :

I would not like to say whether it would or would not, but my opinion would be that it would not. I have never had experience with oil and I do not know how hot you can get it. I know however that such tests have been made with forge fires, and oxyhydrogen blow pipes, the hottest fires that could be made, and it has been impossible to burn a sheet to the danger point.

■

If you can boil water away from a sheet and burn it, (the sheet) there would be no safety in any boiler built, and if any one really thought so—he certainly would never ride another foot on a locomotive

As Professor Goss said, as aforesaid, steam can be superheated right through iron without superheating to the danger point.

But, the crown sheets, when not covered with water will burn, and when so heated, that is to say to the burning temperature, if an accident releases water, the heated metal disassociates the constituent gases of the water or steam; this may occur at heats below the red heat or burning temperature, then in that way releasing the irresistible power that results; the men in the locomotives suffer in the loss of their lives or limbs and the Railways suffer the loss of their property, as well as in damages.

As seen in the said test and in the discussion in the Western Railway Railway Club, the condition is not an unknown condition; it is however not well known to the men in the Cabs of the locomotives; and in the habitual failures of the Railways to inform the men of the risks of explosions under the conditions of the staying, there is continuous wrong, and when false causes are alleged, a disaster is more than an aggravation.

If the boilers of the S.S. Titanic had been so protected as to delay the spread of the waters to the boiler rooms, there would have been time for the Captain of the S.S. Californian to have awakened from his stupor, and gone to the aid of the 1517 persons who were lost by the explosions—which broke the back of the Titanic, and hurried the ship with her people to the bottom of the Ocean.

The Iceberg made the tear in the ship's side which admitted the water, its spread could not be hindered, it reached the boilers and was disrupted.

Pittman, the 3rd Officer of the Ship was asked by Lord Mersey :

" Do you believe that the boilers exploded ? "

" I do not, and I was near enough to know. "

That was direct proof that the explosions did not take place

within the boilers; the only way the explosions could be accounted for was by the disruption of the inflowing water, from which there was no protection; as it came into contact with the grate bars and other heated parts; by the disruption there was the dissociation of the gases in the water releasing the power that caused the deaths of the Engineering staff who were on duty.

Mr. Bride, the Surviving Marconi Operator, said;

"Only ten minutes elapsed after the collision before Captain Smith appeared in the operating room and ordered the call for aid to be sent."

When Captain Smith received the reports about the water entering the ship (Senate Report) he promptly gave the order to clear the life boats, and to put the women and children in them.

Pittman, 3rd Officer :

"I left my cabin about 11.50 on Sunday night, just after the collision. To satisfy myself I went forward, I saw the Ice, then walked back. I saw a flock of firemen coming up, I asked them what was the matter and they said there was water in the hatch; I looked down and saw water flowing over the hatch."

There was nothing in that about explosions.

Barret, the Head fireman of the Titanic, later of the Olympic :

"Swore that he was the first man to see the water coming through the sides of the ship. The tear, he said, extended through the side of the forward fireroom, the water came from a point about 20 feet below the Sea level, and rushed like a mighty torrent into the ship, five compartments filled almost instantly. There were only two in the forward compartments of the ship who escaped. 24 out of 29 of her boilers were burning. Within five minutes after she struck, the ship listed 5 degrees."

There is nothing in that about explosions, though the danger was near.

From the Senate Report :

"The testimony shows that coincident with the collision air was heard whistling or hissing from the overflow pipe to the forepeak tank, indicating the escape of air from that tank because of the inrush of water. Practically at once, the forepeak tank No. 1 hold, No. 2 hold, No. 3 hold, and the forward boiler room

filled with water, the presence of which was immediately reported from the mail room and the racquet court and trunk room in No. 3 hold, and also from the firemen's quarters in No. 1 hold. Barret saw the water rushing into the forward fireroom from a tear about two feet into the coal bunker at the forward end of the second fireroom."

I have mixed my comments about a condition in marine and locomotive boilers, about which there is constant unheeded danger, which was felt in the Titanic when the water reached the heated iron surfaces, as seen in the consequences now quoted about the explosions.

Frank Osman, Seaman, who was on the life boat of the 4th Officer :

"The ship after she got to a certain angle exploded and broke into halves. It seemed as if all the engines and everything that was in the afterpart slipped out and the afterpart came upright again. As soon as it came up it went down again."

Lightholler, 2nd Officer of the Titanic, Per question and answer said :

"Were the watertight doors so arranged as to protect the vital parts of the ship?"

"He believed not."

"Does not a warship have its boilers protected?"

"It is done to protect them from Shell fire."

"Yes, but would they not protect merchantmen from water in case the stem of the ship were pierced."

"Probably they would, I don't care to express an opinion as to what should be done to protect the Ship's boilers. It is a matter for serious consideration."

There was a seeming knowledge of the danger of water flowing to the boilers.

Pittman, 3rd Officer :

"She settled by the head. Then suddenly she got on end and dived down. I heard four explosions ; they sounded like big guns in the distance ; the explosions followed the dive of the ship almost immediately."

Geo. F. Crowe, a Steward :

"After we got clear of the Ship, her lights were still burning brightly, but as we got away she seemed to go lower. Her lights went lower and presently she broke clean in two. Probably two-thirds of the length of the Ship was in the water and one-third of her aft the funnel was sticking up. She broke and the afterpart floated back. Then there was an explosion, and the afterpart turned and sank."

Condensed Press Reports gleaned from Survivors.

From the Star:—"Three seconds after the Titanic was engulfed a great spout of water shot upward from the explosion of boilers." There must have been at least thirty explosions in the furnace rooms as the water poured down the funnels and reached the fires."

From the Witness;—"The Titanic struck an Iceberg 90 feet high. The shock was light, it ripped the liner's sides and made the watertight compartment useless; while the vessel was gradually sinking the icy water reached her steaming boilers, and caused an explosion that sent her to the bottom."

From the Gazette: Alice Cleaver, Nurse, informant.

"When we put out on the boat, I heard an explosion. The whole end of the Ship went right backwards into the sea."

From the Gazette: C. F. Hurd, also Whitman:

"It was the explosions of the boilers which finished the Titanic's career. The position of the Ship's wound on the Starboard side admitted water, which caused the boilers to explode and these explosions broke the ship in two. The machinery was so damaged that the front compartment failed to close tightly. Whitman was blown off the deck by the second of two explosions. The explosions were caused by the rushing in of water on the boilers. The crew and passengers had faith in the bulkhead system to save the ship, and were lowering a collapsible boat, all confident that the ship would get through, when she took a terrible dip forward and the water rushed up and swept over the deck and into the engine room. The bow went clean down. Then came the explosions, which blew me fifteen feet."

From the Gazette, Whiteman, passenger :

"There is much and yet there is little, to tell of my experiences. My father and I had given up hope for life and were standing together, resolved to jump together and to keep together, if we could, so long as either of us lived. I had on my fur overcoat. The forward end where we stood was sinking rapidly and before we could sink together, the water washed my father over. Then with the explosions, the ship seemed to break in two and the forward end bounded up again for an instant. I leaped but with dozens in the water between us my father was lost to me."

From the Gazette, written by Mr. Beasley of London :

"I had been in my berth about ten minutes when at 11.15 p.m. I felt a slight jar, and then soon after, a second one, but not sufficiently large to cause any anxiety to any one however nervous."

Omitting other interesting matter, taking only Mr. Beasley's remarks on the machinery :

"However the engines stopped immediately afterward. The engines had been stopped to see if any damage had been done. A little later I went up again and found every one wanting to know why the engines had been stopped. Naturally with such powerful engines as the Titanic carried, the vibration was very noticeable at all times. Presently about 2 a.m., as nearly as I can remember, we observed her settling very rapidly, with the bow and the bridge completely under water and concluded it was then only a matter of minutes before she went down and so it proved. She slowly tilted straight on end with the stern vertically upwards, and as she did, the lights in cabins and saloons, which had not flickered for a moment since we left, died out, came on for a single flash, and finally went altogether."

"At the same time the machinery roared down through the vessel in a rattle and groaning that could be heard for miles, the weirdest sound sure! that could be heard in the middle of the Ocean, a thousand miles away from land. But this was not yet quite the end. To our amazement she remained in that upright position for a time which I estimate at five minutes, while we watched at least 150 feet of the Titanic towering up above the level of sea and looming black against the sky. Then with a

slanting dive she disappeared beneath the water and our eyes had looked for the last time on the gigantic ship."

From the Witness :

Among the Mariners in Port the fate of the Titanic was discussed. The loss of the ship was to them one of the mysteries of the deep. Her hidden settling by the head and final dive to the bottom, they were inclined to credit to the breaking away of her engines in the head of the vessel. One Officer said he had not a particle of doubt but that the engines were at the bottom of the sea before the ship took her last plunge beneath the water. Her great engines would rain down through the hull and if one could examine that hull now, he was sure that it would be found riddled where the heavy engines had gone through it. It was the machinery breaking away that ended the career of the ship.

From the Gazette, by a Survivor on the Carpathia :

"When her life-boats pulled away from the Titanic the steamer was brilliantly lighted, the Band was playing and the Captain was standing on the bridge giving directions. The bow was well submerged and the stern keel rose high above the water, suddenly the boat seemed to break in two. The next moment everything disappeared."

From New York, as told by a fireman on April 20.

"The Engineers stayed by the pumps and went down with the ship. The firemen and stokers were sent on deck five minutes before the Titanic sank, when it was seen they would inevitably be lost if they stayed longer at the work of trying to keep the fires in the boilers and the pumps at work."

There must have been many dead from the explosions before the Titanic sank, many injured unable to save themselves, some may have been off duty and the few of the latter were the most fortunate.

There were in the Engineering department of the ship exposed to the risk of explosions, from the inflow of the water coming into touch with the heated metal, with the grate bars and other heated parts, which gave the great lesson to the world, which imposes a responsibility for death, 314 in the Engineering department :

Smoke and Explosions

6	Electricians,	all dead.
175	Firemen	129 dead.
72	Trimmers	51 dead.
25	Engineers	all dead.
26	Greasers	24 dead.
2	Boiler-makers	dead.
3	Store-keepers	dead.
1	Plumber	dead.
4	Mess-Stewards	2 dead.

Some have doubted the breaking of the ship in two, but the evidence is in sufficiency, the tearing of the heavy engines and machinery from the fastenings is also proof of the irresistible power, and the same will be shown in the

WINDSOR STATION DISASTER.

I refer to this disaster because it illustrates the irresistible power that was its cause, the same that broke the back of the Titanic; it is an always imminent, but avertible danger, it is treated with indifference, until disaster comes, then the true cause is suppressed.

In January 1909, Railway & Locomotive Engineering said on that weakness in right by Railway masters; who in this case suppressed the truth:

"When the supreme accident, a boiler explosion happens to a locomotive we are frequently asked to give an opinion as to the cause, especially when the rupture was begun in the firebox."

"When that happens the officials of the road nearly always charge the explosion to low water and try to saddle the blame on the engineers. Boiler explosions are much oftener caused by broken staybolts or furrowed seams than by low water; but low water is an easy explanation that is readily understood and it tends to relieve the Company from the payment of damages caused by the accident."

Quoting the Star report of the Windsor disaster:

"With the throttle wide open, the furnace at white heat, the Engineer blown from the Cab, and the fireman missing, the big Mogul engine pulling behind it the Boston Express, due here at

8.20 this morning, dashed through the city suburbs at a speed well on to 40 miles an hour, over switches and round curves, passed white faced gatemen, then through the west end opening of the depot, along No. 7 Track, and with a mighty force that shook the entire neighborhood, ploughed through the massive walls of the depot, through the ladies' waiting room, on yet farther to the General waiting room, and then ten feet from the Windsor street wall—stopped, stopped with one of the wildest scenes of death and confusion ever known in Montreal.

"Straight through the lavatory the train had cut, and crossing the ladies' waiting room it had torn away great pieces of the ceiling in its course. The floor, unable to sustain the weight had caved beneath the strain and a great hole was torn in the wall close to the windows."

"The engine brought to a stop after its passage through the thick inner walls and its impact against the great Pillar of the main waiting room, halted in the middle of the latter, panting like some monstrous animal at bay, steam escaping from its damaged boiler, in its wake it left destruction and death. The cab of the engine resisted the passage through the walls, and brought up against the partition of the ladies' waiting room, where it is heaped a pile of ruins, and yet distinguishable among the surrounding wreckage. Just beyond it and nearer the Tracks, the tender is crushed out of shape, and hopelessly caved in through the floor. Behind it stands a damaged baggage car, part of it has not even its varnish injured; where the floor has given way there is simply a collection of debris. The great girders are twisted and bent out of shape."

"It was in the thickest part, where the debris lies in heaps, that the killed and injured were largely found."

"The rest of the ladies' waiting room looks as if a whirlwind had struck it....battered and big and beligerent even in ruin, the great engine dominated everything around it, and reared itself high upon the debris as if conscious of what it had done."

"A cabman who was sitting in the waiting room when the big black monster ploughed through two walls of granite told his story to a representative of the Star; he had a finger badly

smashed by the seats ; first the west wall crash occurred, seats began to shove and a dark and terrible spectre emitting steam pushed its nose through the shattered wall."

"The final trumpet of destruction sounded when one of the pillars in the room went down with a crash, pinning under it a little eight years old girl."

"The cabman was so shocked with the fright that he was hardly able to relate a connected story."

"He said they had no warning in the waiting room, other than the rumble of the oncoming train which was not unusual. The first incident to warn the occupants of the waiting room, was the crashing of the east end wall of the building which occurred only a few seconds before the locomotive ploughed through the west wall of the waiting room."

"A scene of unutterable destruction and confusion then ensued, windows flew in every direction, the steam emitting from the shattered boiler of the locomotive filled the tall waiting room and added to the confusion.

"There was a wild rush to get out of the waiting room ; but as soon as he, the cabman and some of his comrades, had time to collect their senses they rushed back into the waiting room to rescue the unfortunates."

WHAT WAS THE CAUSE ?

Cause and effect are related subjects ; from a study of the effects in most of the explosions, when the study is on facts, rather than on theories, say as a reporter might be informed of the facts by even a fireman from out of the wreck, the cause is understandable ; knowledge of conduction, circulation, etc., familiar to all engineers, simplifies investigation ; there is hardly an excuse for engineers who assert an erroneous cause, and it is a criminal act to mislead a Coroner's Jury, who are sworn to discover cause.

To determine the cause of an explosion is a matter of great importance, that being essential to the inventive brain of the mechanic to have a care to prevent its recurrence, and to save

good men from too previous death without warning when performing their duty in a locomotive.

To authenticate an erroneous cause, is an act of deceit in pursuing justice in the interest of the public ; as aforesaid, in the quotation from a scientific railway paper, one erroneous cause, often alleged, contemplates unjust complaint against the men in the Cab to reduce their claims for damages, but worse than that, every easy settlement makes indifference to loss of life, indifference to humane provisions for safety to life.

That disaster was said by Mr. Vaughan to have been due to the breaking of a wash-out plug, an infrequent cause of disaster ; so infrequent as to be never, and the evidence so conveyed to the Jury, produced that finding by the Jury.

When the explosion took place, newspaper reporters were alive to get the facts and cause on the spot :

The Herald on March 17, 1909, the day of the disaster, after investigation said : "The cause of the accident is one of the most peculiar features of this extraordinary occurrence. When the C. P. R. Boston Express was approaching Montreal West, three staybolts, which support the rivets holding together the plates of the boiler, gave way, with the result that the boiler blew out steam with such force that the Cab gave way to the pressure and the "engine driver and fireman had to jump or be scalded to death by the escaping steam."

Not because of the breaking of a wash-out plug, but because that "when the C. P. R. Boston Express was approaching Montreal West, three staybolts gave way," in other words, they were broken, there was strength in sufficiency, for the remainder of the trip, but there was danger from the leakage of the water coming into contact with the heated bolts, disrupting the water, releasing the irresistible power, which blew the Engineer and the air before him, out of the Cab, it was not a case of scalding or jumping, though there was both, it was the dissociation of the constituents of the water or steam, made possible by the breaking of the three staybolts.

Press subserviency to influence gulls the public :

On the same day that the cause assigned for the disaster was

broken staybolts, the Herald made its headlines read—"Plug blew out of the locomotive."

On March 17, 1909, the cause of the disaster as in the Star, was given as broken staybolts, later I wanted a copy of that edition but could not get a copy, it was said to have been exhausted, instead I got a copy in which it was said:

"The accident was undoubtedly due to the blowing out of the plug of the engine, just after it left Westmount Station. The Engineer was blown from his Cab, and the fireman was so injured, that he either fell from the train or jumped."

And after the Coroner's Inquest as reported in the Standard on the 20th of March 1909, and in the Gazette, Herald and Star of the 22nd, the verdict was that the control of the said locomotive was lost through a plug of the firebox blowing out.

The Star and the Herald anticipated the finding of the Jury some days before it was rendered, and they also found on the same day that the cause was because of broken staybolts, the latter was the first cause of the disaster and an explosion from the disruption of the water released by the broken staybolts, was the cause.

The Engineer weighed 205 pounds, a few minutes after leaving Montreal West, he was blown out of the Cab, not by water or steam, but by the expansion of the gases dissociated by the contact of the water or steam in the contact of the latter with red hot iron.

The cause was not obscure, the explosion was not caused by the wash-out plug; every man as aforesaid is responsible for his acts of injury to his fellowman, and misleading causes lure men to their injury and death as seen in the following sample cases from the Press, the plug being again the scapegoat in

THE NORTH SHORE DISASTER.

"Nearly suffocated by blinding steam, which poured from his firebox, Edwards jumped from his post to death, between St. Augustin and St. Scholastique. A similar accident to a locomotive caused the Windsor Station catastrophe this spring."

"The train left Ottawa on schedule time, and at the time of the accident was going at the rate of 35 miles an hour."

"As the train reached a point about two miles west of St. Augustin a blinding sheet of steam burst out of the firebox."

"Fireman Edwards, burned horribly, staggered to the side of the Cab, but there the steam was as bad. Surrounded by the stifling steam, he jumped from the train to the ground, a distance of about 14 feet."

"The Engineer, who was almost stifling, got hold of the throttle and shut off steam, as he crawled out of his Cab to a place of safety on the running board. There he clung until the train had spent its impetus."

"As the train slowed up, the Engineer feared the worst, he called loudly for his fireman. He had seen Edwards overcome with the steam which flooded the entire Cab and tender, had seen him endeavor to crawl up on to the coal, and unable to get relief, saw him stagger near the Cab-door. The Engineer unable to find his fireman, started up the track; about three-quarters of a mile up the track the fireman was found dead."

"At the request, Engineer Wilson described the circumstances in detail, though he spoke falteringly. There was nothing the matter with the Engine when it left Ottawa. No leakage in the firebox denoted a defect. An explosion in the firebox caused the blowing out of the fire plug. Such accidents were infrequent. The verdict of the Jury was accidental death."

The adoption of an irrational excuse is the link in a chain of disasters, and silence about the cause—is indifference to its danger as a menace to life and property, while gulling the public, by fooling the Coroner and Jury.

A credulous public accepts as true, the absurdity, that the explosions were caused by the blowing out or breaking out of wash-out plugs.

The flow of water from a plug hole, at the bottom of the boiler, would so lessen the power in a locomotive that the engine would come to a stop.

The absurd pretence that the Windsor Station disaster was caused by the breaking of a wash-out plug, attracted attention;

A Railway expert of long and varied experience said in a letter to the Standard on March 20, 1909.

"That the escaping steam of itself would have withdrawn all motive power from the engine in two lengths, and had the train been on the level it would have stopped. There was no high pressure of steam in the boiler, when the train left the summit. The train came to the Station by her own weight on the incline alone, gaining momentum the further she went."

The Train momentum was accelerated by the expansion which resulted from the dissociation of the gases in the water when it was disrupted.

"When the C. P. R. Boston Express was approaching Montreal West—three Staybolts gave way."

"Just after the train left Westmount Station, the Engineer was blown from his Cab, and the fireman was so injured that he fell or jumped."

"The accident was undoubtedly due to the blowing out of the plug."

Water leaking from a hole could not blow the Engineer out of his Cab.

An old Railway Engineer, said :

"I don't want any evidence, I know that Mark Cunningham (the dead Engineer), did his duty and the best, he was the sort of man to do more than demanded of him. When the steam blew into the Cab, the Lord knows how, Mark did not bother about the throttle, as some of the papers have it, because the throttle could have no effect on steam escaping through a defect."

There was an honest ring in that speech of the old engineer, he wanted none of the evidence that was being fed to the Jury, he did not believe in the wash-out plug, by which the Star and Herald had been fooled, and the Coroner with his Jury made to bring in an erroneous finding.

An Engineering Expert in a special to the Standard March 20, 1909, said :—"With regard to the possible cause of the C. P. R. disaster at Windsor Station, it was due to one of two things, namely :

"The blowing out of one of the Staybolts, or

"By the failure of one of the crown sheet stays,"

The Titanic disaster and other disasters are loud demands for humane consideration for the safety of the people, but safety cannot be assured by alleging false causes.

The first cause in the Titanic disaster, was the Iceberg, the final cause was the disruption of the water when from its wounded side it reached the boilers—and the explosions were the natural consequences.

The Windsor Station disaster continued :

"Mr. H. H. Vaughan was called to give expert evidence .

"He did not see the accident, but the conditions were stated to him and he unhesitatingly credited the runaway with a speed of fifty miles an hour."

At the time of the explosion the train was running at 25 miles an hour, but the released power from the disruption of the water and steam, which was the explosion, increased the speed, possibly to fifty miles an hour, and the same sudden power blew Cunningham out of the Cab.

"As to the initial accident, the blowing out or knocking out of the plug, Craig the fireman, says that it was an explosion like a cannon going off (but Craig did not say the explosion was caused by the plug) and the action of Cunningham in remaining for a few moments trying to control the engine (there was no legal proof that Cunningham remained for a few moments trying to control the engine, the open throttle denies that supposition,) while being literally boiled with the scalding steam, was an act of genuine heroism with few parallels in the history of railroading."

No doubt, Mark Cunningham was a hero, he was a good man, and would much rather have lived the years of his natural life, than have been blown out of the Cab, a dead man, and have an oration on his heroism, over his body.

His death was as prompt as the explosion from the disrupted steam, not from the wash-out plug, which Mr. Vaughan introduced into the case with intent to steer suspicion of cause from the staybolts.

"Louis Craig, the fireman, was assisted into Court by his

brother, he had his head bandaged and his face showed the terrible punishment he received."

"The explosion he said, was terrific and as loud as a cannon."

"He could not tell at the moment what had exploded."

"It was on his side of the locomotive that the explosion occurred."

The wash-out plug was not on the side of the locomotive.

"He had just finished putting on a fire and was sitting on his seat when the crash came. He did not know what the engineer was doing at the time, when he saw him last he was sitting on his seat. His first thought after the report when he found he was being scalded to death, was to save his life; when the scalding water struck him in the face, he concluded that the boiler had burst up and he threw himself out of the side window. He landed on his hip and rolled into the ditch."

"At Highlands, there was a leak of steam. He noticed the leak at Highlands for the first time, steam and water were oozing from the firebox."

The mere oozing of water or steam would not cause an explosion, except in contact with dark red (or hotter) iron.

Louis Craig, the fireman says further: "He had just finished firing and had resumed his seat, when there was an explosion right under his seat from the boiler, with a noise like a cannon exploding, and immediately a tremendous gush of steam and water burst into the engine cab. He had not even waited to think but at once jumped out of the window, landing on his shoulder in the snow, which probably saved his life. What had exploded, he did not know, but it came from the side of the firebox."

"What was engineer Cunningham doing?"

"He did not know, he had not spoken to him since the train started at Highlands, and did not stop to look at him before jumping."

"What was the result of the explosion?"

"I heard a sudden terrific bang, then the steam and water struck me and I went out."

"Was anything wrong when you stopped at Highlands?"

"There was a leak of steam from the firebox, about the same place as it exploded, but it was not serious and no attempt could be made to repair it."

The train should have been uncoupled and the fire smothered.

That was the defect, and the three staybolts, to which Mr. Vaughan, the expert witness, should have directed the Coroner, and his Jury.

That leak, and the three broken staybolts, were warnings, an explosion was due at any moment, that the leak came into contact with hot iron; the inner ends and necks of the staybolts are nearly always at the dark red to red temperature; in one showing that came under my notice, 40 per cent of the ends were burned. It was as unwise to take chances as it would be for a man with a lighted cigar or a match to walk through a powder factory, but the chance was taken and in two or three minutes after leaving Montreal Junction, the violent explosion and the Windsor Station disaster with the cruel loss of life and destruction of strong stone buildings was proof of the irresistible power released in the dissociation of the constituents of the water.

When erroneous causes are imposed on a Coroner's Jury, and the words are in that way authenticated, the causes are repeated as in the North Shore Disaster, in which Wilson, the Engineer, a good man, who when he was before the Coroner and his Jury, in faltering words, told that an explosion in the firebox (which was true so far and no further) caused the blowing out of the fire-plug, such accidents were infrequent.

The "plug" and "infrequent" were creations of Mr. Vaughan.

This following case also claimed kinship to the Windsor Station case;

"But for the bravery of Engineer Thomas Bennett of the C. P. R. Express, east bound, an accident similar to that which recently occurred at the Windsor Station, Montreal, might have happened here (Smiths Falls) this morning. Fireman Martin Riley was blown out of the Cab and onto the Tender, he escaped with slight injuries. Engineer Bennet was badly scalded about the face and arms."

This and the North Shore fatality, was said to be similar to

the Windsor Station disaster, but Fireman Riley could not be thrown out of the Cab onto the Tender by a wash-out plug ; the identification of real cause is however sufficient for all three, and nearly all the explosions on locomotives are of the same fulminating kind as in the Windsor Station wreck.

It is certain that the explosions on the Titanic were not from cause in the boilers, it is certain that they were from the disruption of the water in contact with the heated parts of the boilers.

The water, for which there was no protection from its inflow, was the greater danger on the Titanic ; the heated parts in the firebox of a locomotive are the heads and necks of the staybolts exposed to the radiant heat of the fire ; the heat it is true strikes the plates, but the plates conduct the heat to the water as fast as it is received ; but, the ends of the stay bolts exposed to the radiant heat of the fire, though in the hottest part of the heat do not fully conduct the heat to the water, because the conduction is arrested by the mechanical connection at the head and neck, they burn, and this burning is continued from the head to the neck in the sheet, and when, by the breaking of a staybolt, water comes into touch with the burning ends or necks of the staybolts, there is then no time for an Engineer to save himself or his fireman. By chance, one or the other may escape with injuries, but only by chance.

The same danger exists in Stationary and marine boilers, but not to the same extent, for stationary and marine boilers do not have 1200 to 1500 staybolts or other bolts exposed to the radiant heat of the furnace fire, all boilers are, however, liable to explode.

One very disastrous explosion was that of the U. S. S. Sultana on the 27th of April 1865, with 1500 lives.

That did not take place in mid-ocean, it took place on the Mississippi.

Another disastrous explosion was that of the Ferry Steamer Westfield, plying between Staten Island and New York, with about 100 lives and as many more injured.

Several causes have been given by men who have studied the question of explosions, and a good deal has been written ; one favorite cause, as before referred to, "low water," is very mis-

leading, as well as unjust ; in an academic paper, published in a technical paper, the statement is made that "explosions of boiler shells and fireboxes, and damage by burning etc., are usually due to low water ; of the failures reported 98.3 per cent were due to low water and 1.7 per cent to other causes. Of the failures due to low water 98.6 per cent were due to the failure of the men handling or in immediate charge of the locomotive to maintain a proper supply of water in the boiler ; the remaining 1.4 per cent were due to other causes." A better understanding of the causes would be in the public interest, and the true causes for bursts blameable to unsuitable material and to malconstruction may be averted by careful inspection. The explosions of the fulminating kind, now frequent, cannot however be averted, as locomotives are presently stayed, except—as in cases like to the discovery of three broken staybolts and a leak in the boiler which exploded and caused the Windsor Station disaster, in that, there were the staybolts and the leak ; the staybolts and the leak lacked only their contact, which was realized a few minutes later, and the fulminating character of the explosion was seen in the terrible tragedy of the Windsor Station disaster.

That disaster might have been averted by smothering the fire and hauling the train away from the locomotive, not the locomotive from the train for there was danger while the men were inspecting the three broken staybolts, and when considering the leak at Highlands.

A better understanding of the causes of explosions by the men in the Cab, would be in the interest of the Railway and in the interest of the public, as well as in the interest of the men, who generally have a finer sense of responsibility, than perhaps the men who deny them that, as in that academic paper.

PRESS REPORTS OF FULMINATING DISASTERS.

A study of this and other reports following, precludes cause of explosion by either low water, wash-out plugs, or the cause given, which is only a supposition :

"San Antonio, Tex., At least 32 men were killed and parts

of their bodies strewn for blocks around when a big passenger engine in the

SOUTHERN PACIFIC SHOPS

blew up here this morning."

"Twenty of the bodies have been identified, but what is believed to be twelve more is little more than a tangled mass of human flesh and bones that probably never will be separated into the dozen humans it represented."

"The fragments were found jammed into crevices, about the buildings wrecked, in the street and entangled in the machinery of the shops."

"The engine was 704 and was practically new. It was in the shops for inspection. It was of the large Mogul type."

"Besides the 32 killed, fifty persons were injured. These for the most part were in remote sections of the buildings wrecked, for those close to the engine or in the main parts of the buildings either were killed outright by the explosion or crushed by falling material when the buildings crumbled. The monetary loss will be about \$200,000."

"Freaks of the terrific impact were many, but one of the most strange is that the driving wheels of the engine were not disturbed. While parts of the huge locomotive were driven blocks, the large wheels did not move."

"Mrs. B. S. Gillis, 62 years old, in her home seven blocks away, was probably fatally injured when the front end of the locomotive crashed into the roof, demolishing three rooms and continuing through to the ground floor of the house."

"Smithville, Texas., Eight white men and two negroes were killed and four injured today by the explosion of a Missouri Kansas and Texas freight locomotive boiler. The engine was blown to atoms, and two others were damaged."

"Syracuse, N. Y., One man is dead and another dying as the result of the blowing up of a locomotive on the Boston and Buffalo Special on the New York Railroad near Oneida this morning."

"Buffalo, N. Y. The engine of a freight train on the New

York Central Railroad blew up early today 20 miles east of Buffalo. The Engineer George Dwyer and his fireman, were killed, and a brakeman was so seriously injured that he died after being brought to the Hospital here."

Buffalo: Engineer, Henry Kable and John Gest, Fireman, of an east bound Lehigh Valley Freight Train were almost instantly killed near Corfu. The boiler of the engine exploded. A brakeman, Meyers, was blown from the top of a string of cars by the force of the explosion. He landed in a ditch and is internally injured. The engine which is one of the larger type, was puffing along the level stretch of track at a fair rate of speed when suddenly there was a terrific explosion. The engine trucks fell into the tracks about 50 feet away from the rest of the train, and the boiler splitting in half, crashed into a heap of bent and twisted boiler plate and pipe in a ditch 20 feet from the trucks. Kable (Kabel) was crushed under the boiler. Part of his head was free. He muttered a few words to Conductor Beuard, who had rushed forward, and then died in agony. The force was such that every house in Corfu shook, and some window panes were broken. Four cars were lifted from the rails.

Buffalo: "One man was killed and three others seriously injured by the explosion of a boiler of a New York Central freight engine between Buffalo and Tonawanda; George Dodd, the fireman was instantly killed, Engineer H. Gilnow and brakeman H. Schuldt, were so badly scalded that they will die, and Conductor W. H. Splaine was badly injured by flying pieces of iron. The engine was coupled to a string of 20 freight cars.

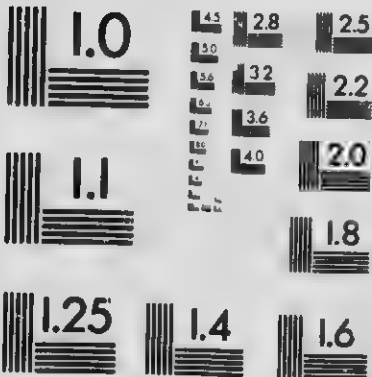
If the Railway managers have any claims to humane feelings, instead of conjuring absurd causes to deceive the Coroner and his Jury, it would be better to study how to have the safety of the men in the Cab and the people on the train assured of their lives and limbs in their travels from Ocean to Ocean.

Probably no more reliable men exist in any trade or profession, than the men who man the Cabs of the locomotives, they are prepared for their duties and knowing that their continual employment and advancement is contingent on their fidelity to their duty, and that their own safety, their lives and the lives of



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all on the train are in their care, they are ceaselessly watchful to guard against danger, as Mark Cunningham was for thirty years of his life, then died a victim, not of an accident, but a victim to a condition in the staying of the firebox, against which he could not watch, because the risk of breakage was in the staybolts and the risk of burning was in the burning of the staybolts, from the fire-sheet inward; there was no steam or water circulation in their mechanical connection, for their protection from burning, no steam or water to protect the necks of the staybolts in the sheets from burning, because conduction was arrested, no way to protect the burning ends and necks from the water released by breakage, no way to prevent the disruption of the constituents of the water with the broken staybolts in their critical temperature; and always liable to an aggravated form of that condition from impurities in the water deposited on the staybolts, which form a coating, preventing conduction of the heat from the bolts to the water between the inner and outer sheet of the firebox, whereby the burning of the ends and necks of the staybolts is continued from the necks under the coatings, as I saw in staybolts taken from a wrecked locomotive on the Norfolk & Western Railway, the said staybolts having been burned about half their length in the water to a spot where the coating had fallen off and permitted conduction to be there resumed, and the burning to be there arrested; but while the ends and necks were burning, the steam pressure in the boiler was against the sheet and the sheet was forced over the burning heads of the staybolts, with disastrous results.

That was the only case that came under my notice, in which bad water had combined with the burning heads and necks of the staybolts and produced disaster, but that which has occurred once, may occur again, and may have occurred again without being published, for the aim of some of the men at the head of the locomotive department is to suppress the true cause.

The late F. W. Webb of the London & Northwestern Railroad, at the International Railway Congress, reported that in a boiler on his Road with 200 pounds steam pressure, he had drilled holes in staybolts, and put a thermometer in them, and found

that at half an inch from the ends of the staybolts, the temperature was 750 Fahrenheit, and Prof. Hibbard said it was reasonable to suppose that the temperature at the end of the staybolt was as high as 900 Fahrenheit.

The 1200 and more staybolt and Crown stays acquire those and higher heats, in each, the heat is not conducted to the water, because conduction is arrested in their mechanical joinings, at every head and neck exposed to the radiant heat of the fire, they represent that extent of heating surface lost by the boiler, converted into snares, for when the iron cannot conduct the heat to the water, the heated heads and necks, when staybolts break and come into touch with the water, are like to the match by which the powder is exploded. The men in the Cab should be informed of this; the workers with dynamite may by care protect their lives, but the men in the Cabs of the locomotives, though always careful, cannot avert an explosion, however careful, nor can they defend themselves after an explosion, against charges of want of care, nor can their heirs refute the evidence of men who say the cause was "low water", nor the evidence of a man in authority giving as the cause of an explosion the breaking of a wash-out plug.

The World wide reputation of the Canadian Pacific Railway for integrity was founded on the unimpeachable character of Lord Mountstephen, Sir W. C. Van Horne, and Sir Thomas Shaughnessy, they would not deceive the public.

I QUOTE A FEW MORE KILLINGS AND WOUNDINGS FROM
THE SAME CAUSE :

"An extraordinary accident occurred on a Grand Trunk Railway Freight train, east bound from Brockville to Montreal at midnight, resulting in serious injuries to the train crews and a complete wreck of the locomotive.

"The train which consisted of 50 loaded cars was a mile and a half east of River Beaudette, on the main line, when the crown sheet blew out suddenly without the slightest warning. The train was running at a fair rate of speed, on a clear line, and no obstacle in the permanent way."

"The fact that although the engine is a complete wreck, the 50 cars are undamaged indicates that the explosion was due to some cause within the boiler and not to any exterior cause."

That theory is incorrect, there is no gain in dodging the real cause.

Another report says :

"The boiler of an engine exploded, the crown sheet was blown out and the boiler shot up in the air, falling across the tracks."

"A similar accident occurred about five years ago near Blue bonnets. The driver and firemen were then blown through the Cab window into an adjoining field."

"Buffalo, N. Y. One man killed and three others injured by the explosion of a New York Central Railroad Freight engine, the men injured so badly scalded that they will die, and the Conductor was badly bruised by flying pieces of iron." The New York Central employs high class mechanics.

"Pittsburg, Pa. Engineer killed and fireman seriously injured, by the explosion of the boiler attached to the outgoing Pennsylvania Railroad Passenger Train about two miles east of the Union Station. The force of the explosion lifted the engine boiler from its trucks and hurled it over an embankment ; several passengers in the first coach behind the engine were injured by flying glass."

The Pennsylvania Railway have the highest class ability, but as in that case, it also made proof that it was operated under conditions, the end of which—death, demands other conditions to conserve life and limb.

The following is another case which shows the necessity for such changes in the staying of locomotives as will assure safety to all who may be on or near to the loco . . . e :

"Metuchan, N. J. Three men were killed and a number of others hurt, Metuchan, was shaken and threatened with fire, when the boiler of a locomotive on the Pennsylvania Railway exploded while drawing a train through the town. The train left Jersey City at 1 a.m., and was passing through this place under good headway, when just opposite the station, the boiler of the locomotive exploded, with terrific force. Hardly any portion of

the locomotive except the wheels, was found at the point of explosion. A portion of the locomotive was blown into Happens Drug store, two blocks from the Track, and another piece of steel entered McCutcheon's Pharmacy; Miss Daisy Martin telephone operator in the Railroad Station, was thrown from her chair by the explosion and slightly injured; windows within a radius of 200 yards were broken by the explosion; portions of the locomotive were blown two blocks away and tore their way into buildings; the bodies of engineer Sisher and brakeman Smith were found a hundred yards from the track; many of the freight cars were piled in a heap, and several train hands were injured in the wreckage. The broken cars caught fire from the scattered coal of the locomotive firebox.

"Little Falls, N. Y., The boiler of a freight locomotive of the New York Central Railroad exploded, causing the death of Chris. Wagner of Albany and fireman Edward Hall of Oneida."

"The boiler was thrown from the trucks high in the air and landed 100 feet away, blocking all four trucks of the Road, a freak of the explosion was that neither the driving wheels nor the tender of the engine were derailed, but ran on with the train for a quarter of a mile. Wagner was thrown from the Cab by the explosion and struck on the Rails of the Passenger track. Fireman Hall was thrown from the Cab at the other side and had his back broken. Eye witnesses of the accident had narrow escapes from being injured by flying pieces of iron. One piece of the locomotive was hurled a distance of a quarter of a mile and knocked down a telephone line.

"The engine had just taken water at Herkimer, and the cause of the explosion has not been ascertained."

The Wabash is another Railroad which employs high class men, but it is also one in common with others afflicted with fulminating explosions:

"While a freight locomotive on the Wabash drawing a Caboose was running rapidly, the boiler exploded, killing three trainmen, injuring two others seriously, wrecking the locomotive and the Caboose:

"Sections of the locomotive demolished the Caboose, and

killed a brakeman. The Engineer and fireman were hurled with parts of the engine and tender 150 feet from the track. The cause of the explosion is not known.

"Notwithstanding his injuries, Conductor Dessert, ran a quarter of a mile west of the scene of the wreck and flagged a swiftly approaching passenger train from Kansas City. He waived his flag three times and fell exhausted and unconscious at the side of the track. His warning saved the passenger train from plunging into the wreck ahead. Dessert was taken to Moberly on a special train after being given medical attention at O'Fallen, but it is believed he will die."

There is no room for doubt about that explosion, it was in the release of the irresistible power, by dissociation as before explained.

The following is another from the same cause :

"Fort Scott, Kan., Engineer and Fireman are dead and a wrecked engine and mail and baggage car are piled up on the St. Louis & San Francisco Railway."

An extract from *Railway and Locomotive Engineering* :

"The Train was proceeding at high speed, some distance beyond Green River, when suddenly an appalling crash rent the air. The Train sped on through a terrifying cloud of white vapor accompanied by a deluge of water (no low water there) that rattled on the Car roof, like the spray of a hurricane in mid-winter in the North Atlantic. Women shrieked and strong men stood still; presently the train slackened its speed and came to a stop, and everybody hurried out to see what had happened. When the air had cleared it was found that the locomotive boiler had exploded and had parted its fastenings, and lay half buried in the earth about fifty yards away; the engine was left intact. The engineer and fireman stood without a scratch and looked like men that woke up suddenly out of a strange dream. Inside the firebox, the flue sheet was riven across and the crown sheet was folded like a piece of paper, back towards the furnace door. When the rupture had occurred, the escaping steam after striking the ashpan to the earth, had recoiled and lifted the boiler into the air. Not a wheel had left the rails. With the exception of a few

broken bolts and the forlorn spectacle of an unattached smoke box to which the smoke stack stuck, the engine seemed ready for a new boiler."

"God moves in a mysterious way his wonders to perform."

The escaping steam did not strike the ashpan to the earth, the power released by the disruption of the steam, after striking the ashpan re-coiled and lifted the boiler into the space from which the air had been expelled by the expansion of the gases released by the disruption.

The same conditions are manifested in stationary boilers, as sampled :

"New York (1910) A boiler explosion killed six firemen outright, probably fatally wounding two others and threw 2,000 women and girls and half as many more men into a panic at the bagging and rope plant of the American Manufacturing Company at Greenpoint, across the East River."

"Circumstances surrounding the explosion are a complete mystery ; without warning the big boiler blew up hurling the eight men through the air to the street ; the roar and the hissing of the escaping steam caused the workers in the factory to become panic stricken. There was a rush for the doors and many of the weaker ones were trampled under foot. When picked up, the bodies of the six firemen were terribly mutilated and it was with difficulty that they were rescued. The other two firemen were rushed to an hospital in a dying condition."

I quote another disaster, to show the irresistible power in dissociation :

"Chicago : Three men were reported killed and ten severely burned by an explosion of red hot liquid metal in the Illinois Steel Co's Plant. The accident occurred in the converting Mill, where hundreds of workmen were employed. About a dozen men were busy about one of the monster tanks full of molten metal. In some way the water which surrounds the tank to keep down the temperature was jarred upon the hot metal ; there was an explosion, accompanied by a burst of steam which enveloped the workmen, injuring them so badly that three died in a short time."

The proneness to place the blame on employees, generally successful in courts, is not always so, the following are exceptions :

Ottawa, Canada : The Supreme court pronounced judgment in the case of the Pere Marquette Railroad Company vs. Waddell, dismissing the appeal with costs for the reasons given by the court below. The judgment holds the Railway, not the employee, liable for a locomotive boiler explosion.

"Rutherford, N. J., The inquest held on the death of John Wadler an engineer and his fireman, Otto Wagner, who were killed by the explosion of an Erie locomotive boiler, was attended by two experts, mechanics. The Erie expert said the fireman had allowed water to run too low in the boiler, and so caused the explosion. The Coroner's expert said the weak and defective condition of the boiler caused the explosion. The Jury returned a verdict saying that the two men were sacrificed because of defective machinery."

"Fredonia, N. H., With a roar that startled every one within a radius of a mile, two large boilers in the Fredonia Power House, exploded, killing L. Burroughs, a fireman, and hurling Wm. Bishop, the 2nd fireman to the top of the Buffalo & Lake Erie Traction Company's house 250 feet away."

"Locomotive No. 1890 on a westbound Wabash freight exploded exactly opposite the Grand Trunk Station here (Thamesville) about 12.30 this A.M. The explosion was terrific awakening the whole town, and burning pieces were blown blocks from the train. The train was in charge of Conductor Cudmore, the engine was one of the Wabash moguls, Engineer Cade of Windsor, being the driver. The whole body of the engine was blown several yards ahead of the lower part of the engine and turned completely upside down. Engineer Cade was found seriously scalded, and is in a very serious condition. Fireman Cook was blown over the top of several cars.

"Los Angeles: The boiler of a big locomotive standing in the Southern Pacific round house here exploded. Two men were killed and three others injured, probably fatally. The

engine was demolished, about fifty feet of the round-house was destroyed and a water tank toppled from its supports.

"The explosion was caused by low water."

I do not think that was the cause. It was a case like to that of the San Antonio disaster, which was also in the round-house.

"Cleveland, O., Twenty persons are reported injured by the explosion of a boiler on the Steamer State of Ohio. The Steamer was at a Dock inside the breakwater, when the explosion occurred."

"Binghamton: A locomotive on the Delaware & Hudson Ry. exploded at East Worcester, killing two men and badly injuring three others. The dead: Engineer Howard Wickham and fireman Jacob Houck.

"Quebec. A Chartrain Engine driver, A. Caron brakeman, and Jobidon, fireman of a freight train, were all more or less seriously injured by the explosion at St. Anne de la Perade of the locomotive of the train.

"Kansas. Two men were killed and four others were injured by the explosion of a boiler."

Denver: Three persons are known to be dead, one probably fatally injured, nine severely injured and three missing as the result of an explosion. So terrific was the explosion that the heavy boiler was thrown high in the air. The property damage is estimated at \$250,000.

"Utica: An engine hauling a work train on the Central Hudson Railway, exploded while running about 15 miles an hour. Seven men were injured, some of the injured are in a very critical condition. It is reported the cause of the explosion was the falling of the crown sheet of the boiler. And that the only thing that saved the lives of the men was in the fact that the force of the explosion was downward. The seat upon which the Engineer and Conductor was sitting was blown nearly a quarter of a mile away and the engine is a total wreck."

The fall of the crown sheet was due to the burning of the heads of the crown stays, the water in contact with the burning stays was disrupted.

On the invitation of Mr. George West (now deceased) on

June 25th 1907, I called at the Railway Shops of the New York Ontario & Western Railway in Middletown, N. Y. to give him my opinion of the cause of the explosion, from the wreck of the locomotive, then seen ; per a memo I then made, I found ;

"The crown stays broken and bent ; the crown sheet damaged ; bursted rivets ; outside sheets twisted and curled ; a large number of staybolts broken in the plates and some of them flush with the plates ; the sheets drawn out thin before breaking."

Those were not results from an over-pressure of steam, they were chargeable to broken staybolts and the disruption of the water or steam.

After looking the wreck over and finding no other reasonable cause, I had a talk with Mr. West in his office, he informed me that he could not think of any cause and that other railway engineers had looked the wreck over, but no one of them could assign a cause ; I told him that there was no doubt that the cause was in the breakage of the staybolts, and the dissociation of the constituents of the water or steam, releasing the only power to produce such an unsightly broken, twisted, wreck, as in the case of that locomotive.

If you are correct in this Mr. Livingstone, there is danger in every locomotive, said Mr. West, Mr. West was a humane man, conscientious and a respected Engineer.

I am of Mr. West's said opinion, that every man on a locomotive is in danger, at intervals, bloody warnings are given as sampled in the quotations aforesaid, quoted to awaken consideration of the evil conditions.

Though explosions are avertible, nothing is done to assure safety to life, other than in care over the material and workmanship, which is not sufficient to avert explosions ; though the highest quality of material is essential to strength and endurance, it is as liable to burn as poor iron, it will however endure more heat before burning.

The U. S. S. Sultana, as aforesaid, exploded 47 years ago, and the lives of 1500 were sacrificed. No doubt the material and workmanship in that case would have been accounted safe, but there was the irresistible power, for it, there was no reckon-

ing. Many explosions have occurred since, some of them quoted, all making evidence of the irresistible power, and their cause is seen in every truthful report in the Press.

The purpose of—

"The U. S. Act 383, to promote the safety of employees and travellers upon railroads by common carriers engaged in interstate commerce to equip their locomotives with safe and suitable boilers and appurtenances thereto,"

May extend only to the quality of the material and workmanship in the boiler, over which the Master mechanics of the railways have a careful watch, and the Inspectors, appointed under the said Act, and the Inspectors for the boiler insurance companies, have a watchful care over the work of the Master-mechanics ; but as there is no suitable iron made to comply with natural conditions for the conservation of safety from explosions, which have origin in the burning and breaking staybolts, explosions follow, however good the material, when by breakage the released water touches the burning staybolts ; the iron should not be made from scrap, it may be laminated or crystallized, and the maker should be reliable.

The conservation of safety from explosions, as from cause for example in the crown sheet, will be understood as generally safe in its staying in a workmanlike manner, the quality of the sheet admittedly good, and the quality of the crown stays also good, both say, of tensile strength for more than the boiler pressure ; but—

The sheet and the stays receive the radiant heat of the fire, the heat passes through the sheet to the water above the crown sheet, the water saving the sheet from burning ; it is however different from the crown stays, they are screwed into and riveted to the crown sheet, that is to say, their connection is a mechanical connection, the heat cannot pass through the mechanical connection to the water, because the conduction is broken, there can be no good circulation and no complete conduction through that mechanical connection, there is therefore no complete conservation of the safety from explosions ; the crown stays burn at the

mechanical connection, because the conduction being broken they cannot conduct the heat to the water.

The natural conditions are aborted by the mechanical joinings of the sheets with staybolts, which failing protection by the non-conduction of the heat to the water or steam are left to burn.

The saving effect of the water or steam is seen in the tests aforesaid on the S. S. Monarch ; S. S. City of Mackinac and in the Sun boiler, in which the iron did not burn ; nor did it burn in the radial stay boiler in the special test aforesaid, in that case it was saved by the steam from the water leg until the level of that water had gone down to $14\frac{1}{2}$ inches below the crown sheet, a dangerous condition, and an explosion resulted.

The tests on locomotive 461 were the same in effect by scorings, Patent 829,871, as the inventions in those tests from pin holes, all my patents, of which I have nine, being conceived for the same purpose, varied in form to suit the available space, at the least cost, in the least space, and no space, the staybolts being utilized, serving their and these purposes without attention, having scorings or pin holes for connecting the steam or water via d' intermittently decomposed in part at d, as in U. S. 853,099 or in Canada 113,056 averting explosions by so cooling the temperature at the head and neck of the crown stays in the crown sheet at d, releasing the oxygen and hydrogen to aid combustion ; the hydrogen in quicker diffusion and velocity encysting the carbon-monoxide, and completing its combustion.

In that way is the only way to perfect combustion, eliminate the smoke nuisance and abort the danger from crown sheet failures.

For more than 100 years the complete combustion of the carbon monoxide has baffled the inventors of the world. Steam-makers, content with imagined successes have found or supposed they had found good in various illusions, tried and discarded, and in air over the firebed, which is provided for in the holes e e e in the staybolts, in every staybolt of the 1200 or more in the side sheets of the locomotive boiler, by which and through the grates, the air carrying its oxygen to the furnace, to all furnaces, promoting the combustion by the hydrogen from d, perfect combus-

tion is attained, and compliance is made with the U. S. Act 383, those conditions for safety not being otherwise obtainable.

Those improvements by which smoke may be eliminated and explosions averted are possible improvements at no greater, I may say at less cost than the present outlay for the staying of the furnaces in the locomotive boilers, including the staying with Swedish iron staybolts, and in their reliability the Master mechanic would cease to be anxious and cause for fear would be removed from men in the Cab, so that they could have a closer watch for dangers on the rail, in the interest of the general public.

That however is not the whole gain, I have said that 50 per cent of the outlay for fuel for the locomotives of the United States and Canada may be saved: Dr. Joseph A. Holmes, director of the United States Bureau of Mines, in his yearly report of the production of half a billion tons of coal says:

"After coal is mined, the losses by no means cease, although some of the culm that formerly went to waste by millions of tons is now being used. Probably not over 11 per cent of the energy in the coal is being effectively utilized. The remainder of the energy is lost through the inefficiency of the steam boiler. It is estimated that the boiler scale in locomotives alone in this country means a loss of over 5,000,000 tons a year. It has been shown that one-sixteenth of an inch of scale means a loss of 25 per cent in boiler efficiency; the losses of carbon that is still pouring out from our chimnies, defacing monuments, buildings, and landscapes, are without valid reason."

In the tests aforesaid on 461, after 560 miles of travel with freight trains, notwithstanding clinkering coal and about 33 per cent of the grate space taken up by a device for producing the hydrogen to burn the carbon-monoxide, the trains were hauled, clinkers gave trouble, but there was no scale on the heating surface, no scale in the tubes, only two-fistfuls of cinders in the front end and not enough smoke to drive Mr. Gilmour (one of the C. P. R. men) from the top of the Cab of locomotive 461.

Major Lacey R. Johnson, a Railway and Marine Engineer of more experience and with a higher sense of duty than some of his

compeers, after study as aforesaid, before those tests, wrote me a letter saying—WORTH TRYING.

The C. P. R. was then so busy, that I had a long wait, Mr. Williams left for the Erie Railroad, I was in his jurisdiction, Mr. Vaughan succeeded to his jurisdiction ; on account of the clinking coal, I wanted one more test with better coal, or on a wide firebox locomotive ; consent, after a refusal, was given, the device was removed from 461, a narrow firebox engine, in Delorimier Avenue, and delivered beside 1212, a wide firebox engine, in the Angus Shops, to be installed in 1212 for another test with the same clinking coal, but that morning Mr. H. H. Vaughan decided that he would not complete the installation, and later I received the following letter :

"Canadian Pacific Railway Company"
Office of the Superintendent of Motive Power,
Montreal,
15th August, 1904.

Mr. John Livingstone,
56 Royal Insurance Building,
Montreal.

Dear Sir,

"I find that the application of your smoke consumer to Engine 1200 will require an entirely new pattern for the grates."

"This is a considerable expense and one that I do not feel justified in going to, and I would advise you that we must consider the test at an end."

Yours truly,
(Signed) H. H. VAUGHAN.

Not a word of regret that my time and expense had been given for nothing, wasted and prejudiced ; nothing has been done to lessen the waste, and millions of dollars have been wasted.

When a man dares to destroy, he should be able to substitute a better. Mr. Vaughan has substituted nothing as good.

Mr. Williams, Major Lacey R. Johnson, and Mr. McNichol considered the question of tests, and Mr. Johnson wrote that my

proposal was WORTH TRYING their wisdom and his wisdom is vindicated in the story of the TWO FISTFULS.

No cleaner tests in 100 years.

What can vindicate Mr. Vaughan in continuing to waste the fuel, making people miserable with smoke, he does not live in it, but there are people who do live in it and have their lives shortened by it.

My invention was not a smoke consumer.

The following from a New York paper is a graphic description of the discomforts from smoke, the heading is in large type :

CINDERS FROM SOFT COAL SMOKE PEST ON EAST SIDE

Blowing from Stacks of Waterside Plant of Edison Company. They fall in showers in the streets and blacken food and furniture.

"Black soft coal smoke rose every hour yesterday and all last night from the stacks of the waterside plant of the New York Edison Company at 39th Street and the East River. Sometimes one of the huge steel chimneys was at work, sometimes two and not infrequently dark smoke was sifting from four to six of the eight chimneys of the plant."

"With the approach of darkness last night the waterside works began to brisk up, The Edison folks supply millions of electric lights throughout Manhattan Borough and they do most of their business at night. That is when the rows and rows of big dynamos in the plant are stored with their maximum "load" of electricity and therefore more coal is needed to drive them. Also it is safer to burn soft coal at night."

"Every night also the soft coal pours from the New York stacks of every other plant of the Edison Company and from every plant of the Interborough Rapid Transit Company and the Long Island Railway Company and the Brooklyn Rapid Transit Company, and dozens of other big factories and shops in greater New York.

COMPLAIN OF CINDERS.

"The worst nuisance at the Waterside plant according to the neighbors, is the cinders. They fall in showers all over the

vicinity, and when the night is damp with no wind, First Avenue and all the cross streets are carpeted with cinders by morning. First Avenue folks have got the confirmed habit of studying the ground while they walk or stand on it, because they know, they say, from sad experience, that when they look up they are apt to get hot cinders in their eyes."

"These cinders drift in at all the windows and spoil the carpets and the bed spreads and the furniture; they blow into the stores and settle on the cakes and pies and other eatables, and they bother the neighborhood day in and day out, month in and month out; so 'tis asserted."

"When there is a wind the black cinder laden smoke from the Waterside and all other soft coal burning establishments in Greater New York are carried long distances, spreading the damage to many of the residential districts, where the public library and other fine buildings are located."

I omit reference to the other offenders, this being only for description of the miseries from soft coal smoke which should have been and can be eliminated, with gain to the owners of the boilers making the smoke.

JOHN LIVINGSTONE.

567 University Street,
Montreal, Canada.

CONCLUSION.

In as few words as possible, I have made clear the necessity for humanitarian and economical conditions by which success may be attained in perfecting combustion, how health may be promoted by eliminating the smoke nuisance, how life may be saved by design in the locomotives and how the men in the Cabs of the locomotives may be saved from cruel death by explosions of their locomotives.

While the printer is at work, I turn again to the subjects, and incidentally to the unwisdom of lawyers in their treatment of the victims of smoke and explosions.

The Montreal Gazette under the heading of a "KNOTTY POINT IN APPEAL" in commenting upon an action by Mrs. Hannah Irwin, the widow of a G. T. Ry. Engineer who lost his life by the explosion of the boiler of his locomotive said :

"They, the Jury, following the remarks of the Judge "that the mere fact that the explosion took place, pre-supposed that the boiler was defective, and awarded the widow \$5,000 damages."

The evidence for cause not being published, criticism is made with the most common cause in mind, probably the real cause by which Engineer Irwin lost his life, for almost every explosion is so caused.

The reasoning by which the Court came to that conclusion, may be supported by reference in argument to the quality of the boiler plate, its tensile strength, stayed with approved stays, their tensile strength, the pressure of steam in the boiler, the workmanship, the whole examined by the engineer a few minutes before leaving Massena Springs.

And as, a few minutes after leaving Massena Springs, the boiler exploded, it is self evident that there was a defect, and the defect not being in the material or workmanship, it may be pre-supposed that the design was defective, and as explosions are occasional disasters on the railways of this Continent over which about 70,000 locomotives are in service, each stayed with over 1500 staybolts and crown stays, manned in all with 140,000 Engineers and firemen, serving the public, as the lawyers say, for the wage compensation vs. the chances of death by explosion,

liable at any time in the common design of staying the inner sheets with stays exposed to the radiant heat, not conducted to the water, to be killed by an explosion, even when standing idle waiting in course of preparation for a passenger train as appears by the following quotation of a disaster in this 1913 :

"Detroit, Mich., January 5.—The explosion of the boiler of a Detroit & Toledo Shore Line Railroad Locomotive here to-day caused the death of one man and the serious injury of six others. The engine was being prepared to haul a passenger train to Toledo when the explosion occurred. James Edward 45 years old, was blown 40 feet and killed.

Conduction of the radiant heat, in which there would be safety, cannot however pass from particle to particle over a merely mechanical connection by screwing and riveting, in that inability is THE DEFECT, and in the failure to perfect the conduction of the heat from the stays to the water is the cause of the explosions, it is in the inability of the railways or insufficient knowledge of their master-mechanics to so design as to avert cause for explosions ; in their inability is the cause of so many lives being lost and so many men maimed and injured, and the cause of so great loss in property destroyed by explosions.

Fireman Craig, at the Windsor Station Coroner's Inquest, was asked :

"Was anything wrong when you stopped at Highlands ?

"There was a leak of steam from the firebox, about the same place as it exploded."

That was a bravely spoken answer.

The explosion took place two or three minutes after he saw the leak.

The leak was caused by three broken staybolts, not by concussion or jar, probably by the dilatations, for the iron was brittle in their then red heat by reason of the non-conduction of the heat to the water.

Though the Engineers in the Cabs are not responsible for faults in design, some one is, but the lawyers for the railways would, if they can, obtain a judgment from the appellate Courts :

"Whether an employer is responsible for the death of an employee, who loses his life as a result of an explosion ?"

"And that question "will be submitted to the scrutiny of Canadian Appellate Courts, only resting when a ruling is obtained from the Privy Council, according to the Plan of the G. T. Ry. in the case of the widow."

As that defect can be eliminated by attenuated jets d' (decomposed at d averting explosions) from the steam space through the heart of the crown stays, and free hydrogen in that operation be produced in the firebox, and as the free hydrogen can overtake and assure the perfect combustion of the carbon monoxide, eliminating smoke, together assuring safety to the men in the Cab, in the same measure as to the passengers on the train, and as the removal of the cause of smoke and explosions counts for a saving of over \$100,000,000 a year to the railways of this Continent, it would be unwise and wicked for the G. T. R. to cause more grief and expense to the widow, in an appeal contemplating the disseizure of her rights in law for the loss of her husband by explosion, and contemplating the acquisition of a right by obtaining a ruling in law, under which, to refuse compensation to the heirs of all others, who may be killed by an explosion.

Remove the cause by improving the design, then the circulation will be improved, perfect combustion will be assured, smoke will be eliminated, explosions will be averted, the operating expenses will be lowered, losses from property destroyed by sparks will be eventualities of the past, and those who now suffer from bronchial troubles will not breathe the smoke, nor have their lives shortened by breathing air made impure by the poisonous carbon monoxide, which can be made a gain to the railways.

It will then not be necessary to put into the mouths of the wounded—as in the case of Eng. Wilson for the Coroner's Inquest over the North Shore disaster: "An explosion in the firebox caused the blowing out of the fireplug. Such accidents were infrequent." "Fireman Edwards, horribly burned staggered to the side of the Cab, jumped from the train to the ground, a distance of about 14 feet. He was found dead."

JOHN LIVINGSTONE.

567 University Street,
Montreal.